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MAYA INSCRIPTIONS DEALING WITH VENUS AND THE MOON

BY

HERBERT J. SPINDEN

Curator of Mexican Archaeology and Ethnology, Peabody Museum of Harvard University; Curator of Anthropology, Buffalo Museum of Science

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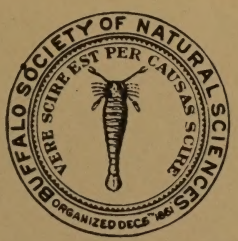

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Foreword

The astronomical science of the Maya Indians of Yucatan and adjacent parts of Mexico and Central America must be recovered from inscriptions of the first centuries of the Christian era and from one native book that luckily survived the Spanish conquest. The present paper is an attempt to demonstrate the significance of many dates and calculations by sufficiency of coincidence after transcription into terms of European chronology. I have explained the correlation of the Maya and Gregorian calendars at length in other papers and have already shown numerous coincidences of an astronomical observatory at Copan constructed to give certain sunset readings.

The present paper is worked up from material brought together for a conference held under the auspices of the Carnegie Institution of Washington in December, 1927. This material includes a revised list of all known Maya dates—which I hope to bring to press in the near future since it corrects many previous errors. Although most of the research was done at the Peabody Museum of Harvard University, I embrace the opportunity to publish the results in the Bulletin of the Buffalo Society of Natural Sciences. This seems especially fitting since by a cooperative arrangement I am now on the scientific staff of both institutions. The XXIII Session of the International Congress of Americanists at New York City, September 17-22, 1928, is a notable occasion for the presentation of this paper.

HERBERT J. SPINDEN,

Buffalo, August 30, 1928.

Addendum

(September 10, 1928)

The days of the Lunar table of the Dresden Codex begin to coincide with solar eclipses about the middle of the Ninth century and continue for several centuries to state not only the eclipse visible in Yucatan and Central America but practically the entire series visible from any part of the Earth. During the First Empire the table, as it stands, is displaced one lunation from actual eclipses. But during the Twelfth and Thirteenth centuries it functions properly and with a usable record of past performances.

Assuming that the table ends, and therefore begins, with 10 Cimi, there are two eclipses which may have served as the inauguration since they take place on such a day and are separated from each other by a multiple of 11,960 days. The first of these is a total eclipse with a line of centrality passing through Peru and northern Brazil and possibly visible in Central America in a partial phase. The second is a total eclipse with a line of centrality passing through Cuba and therefore visible in Yucatan in almost total phase. The first date is 11-1-15-3-6, 10 Cimi 19 Yaxkin, April 23, 999 A. D., equivalent to Julian Day 2,086,050, and the second and perhaps more likely one is 11-6-14-15-6, 10 Cimi 9 Mac, July 18, 1097 A. D., which is equivalent to Julian Day 2,121,930. The first eclipse is the 5239th in Oppolzer's Canon falling on Julian Day 2,086,050, at 17 h. 3.8 m., world time. The second is described as having taken place on Julian Day 2,121,929 at 20 h. 47.5 m., world time.

Many other eclipses visible in Maya territory are properly placed for the named days of the table.

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Maya Inscriptions Dealing With Venus amd the Moon

By H. J. Spinden

Introduction

This paper deals with inscriptions on ancient Maya monuments and with passages in the Maya book called the Dresden Codex which relate to Venus and the Moon. The transcription of dates is in accordance with the day-for-day correlation of Maya and European calendars fully explained in my *Reduction of Mayan Dates.*[1] While this correlation has been accepted by several leading Maya scholars on the proofs already presented, others have hesitated principally because the dates given in the Dresden Codex in connection with the Venus calendar do not fall into obvious agreement with significant appearances of this planet and because the statements in the Supplementary Series of glyphs, which follow the Initial Series dates on monuments of the First Empire do not agree superficially with true positions of the Moon at the stated times.[2]

[1]Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, Vol. VI, No. 4, Cambridge, 1924. The original announcement of the correlation was made in 1919.

[2]At a conference held by the Carnegie Institution of Washington in December, 1927, the opposition of John E. Teeple was based on the matter of Venus and the Moon while Eric Thompson withdrew his rival correlation in view of the new evidence presented. Morley's transcription of dates, while not of the day-for-day type necessary for astronomical uses, generally results in the same Christian year as the one under discussion. Tozzer and Blom have used the day-for-day adjustment but without much critical comment, and foreign students have mostly been non-commital. Juan Martinez y Hernandez of Yucatan has argued a rival correlation resting on a re-consideration of double datings and other historical evidence of the Sixteenth century.

John E. Teeple has written the following articles in the American Anthropologist, 1925-27. *Maya Inscriptions: Glyphs C, D and E of the Supplementary Series* (N. S. xxvii, pp. 105-115). *Maya Inscriptions: Further Notes on the Supplementary Series* (N. S. xxvii, pp. 544-549). *Maya Inscriptions: The Venus Calendar and another Correlation* (N. S. xxix, pp. 278*-282*) and *Maya Inscriptions IV* (idem, pp. 283*-291*).

Other recent correlations are by:

Juan Martinez Hernandez, *Paralelismo entre los calendarios Maya y Azteca,* Diario de Yucatan, Feb. 7, 1926.

J. Eric Thompson: A Correlation of the Mayan and European Calendars. Pub. 241, Field Museum of Natural History, 1927. (Anthropological Series Vol. xvii, No. 1.)

These are based on a structural possibility fully discussed by Morley and myself, namely the identification of Katun 13 Ahau of the Sixteenth century with the position 11-16- 0- 0- 0, 13 Ahau 8 Xul instead of with the position 12- 9- 0- 0- 0, 13 Ahau 8 Kankin. The only authority for this arrangement is page 66 of the Chronicle of Oxkutzcab, which is contradictory of much important evidence. Martinez

(*Continued on bottom of page* 6)

The true basis of Maya chronology is not one of the several calendars—whether of the civil year, the Moon, Venus, Mars, or some other planet—but it is the continuous and inviolate count of days which finds its nearest European counterpart in the Julian Day system of astronomers.[1] In this day count the Mayas seem to have kept an ephemeris or journal of mundane and celestial events. Intervals between recurring phenomena, such as new moons, or solstices, or heliacal risings of planets, were obtainable from this day count by simple averages. Indeed astronomers during the early centuries of the Maya civilization seem to have had sufficient data for compiling various kinds of order in error among the planetary movements and may well have reached most interesting conclusions on the nature of the universe.

Maya Calendars without Intercalation

We have evidence that the early Mayas formulated a series of calendars for civil and religious use, basing them on the mean times of apparent or synodic revolutions of the Earth around the Sun, of the Moon around the Earth and of several planets, including Venus, around the Sun. About the only evidence, so far deduced, that the

[1]The Maya Long Count is first of all merely the succession of index numbers following from a formal zero day in much the same fashion that the year count of the Christian Era is a succession of index numbers following from a formal zero year, namely the one in which Christ was supposed to have been born. Days in these Christian years are designated by the short cycle of the week and by positions in the several months. Similarly in the Maya system days are differentiated by a cycle which is, however, much longer than our week, since it consists of a permutation of 13 numbers and 20 day names, making 260 changes. The Maya day designated by one of the 13 numbers combined with one of the 20 names—1 Imix, 4 Ahau, 13 Akbal, etc.—is stated to occupy a definite position in a civil year which consists of 18 months of 20 days each plus five complementary days, making 365 days in all.

A complete Maya date can be written thus:

1,253,912, 1 Eb 0 Yaxkin.

It might be read "A day called Eb associated with the number 1, which is one of 260 ways in which a day can be named, occupies the zero position in a month called Yaxkin, which is one of 365 positions in the civil year, and it is exactly 1,253,912 days distant from the zero day of the Mundane era which is 4 Ahau 8 Cumhu." The number alone counted forward from the Mundane era will recover the day and month position. Without the number the "calendar round" statement 1 Eb 0 Yaxkin recurs at intervals of 18,980 days (52 × 365 days).

As a rule we do not write the number according to the Arabic system but in a system which preserves the Maya notational units. Thus the above date is generally written 8-14- 3- 1-12, 1 Eb 0 Yaxkin. Here the highest place values are at the left and we have 8 × 144,000; 14 × 7,200; 3 × 360; 1 × 20 and 12 × 1, which reduce to 1,253,912. Also the numbers are generally read with Maya designations for the place values, namely 8 baktuns, 14 katuns, 3 tuns, 1 uinal and 12 kins for the example before us.

(*Continued from bottom of page 5*)

also makes use of a double date in which he makes two emendations, one of several days and the other of several years in the Julian equivalent to the Maya date. A new argument for the structural arrangement used by Morley and myself is found in a statement of Juan Pio Perez, in his early article on the Maya calendar, that the katuns began on the second day of the Maya year. Now he thought that katuns were 24 years in length instead of 7200 days. But the only katun termination that meets the condition was the last one to be recorded in heathen times, namely:

12- 8- 0- 0- 0, 2 Ahau 3 Pop, Aug. 5, 1516 A. D.

Hence it seems that some statement concerning this position must once have existed.

Other recent works to which frequent references are made include:

S. G. Morley, *The Supplementary Series,* Holmes Anniversary Volume, Washington, 1916. *Inscriptions at Copan,* Pub. 219, Carnegie Institution of Washington, 1920. Also *"Archeology,"* in the Year Book of the Carnegie Institution of Washington, Nos. 13-26, 1915-27.

F. Blom and O. G. La Farge, *Tribes and Temples,* 2 vols. Tulane University Publication, 1927.

Mayas may have observed sidereal as well as synodic revolutions is a kind of zodiac consisting of thirteen signs or houses, which was surely in existence during the last centuries of their civilization.

The great problem of calendar makers among all peoples is that of intercalation. Perhaps the commonest type of original calendar is the luni-solar one. Here the problem is to adjust the apparent movements of the moon and the sun, which give rise to the lunation and the tropical year. Most American Indian tribes have calendars of this kind and we may assume that the Mayas also had a luni-solar calendar at the time they started their day-count. Schemes for intercalating entire months are developed by peoples having luni-solar calendars and occasionally an effort is also made to find rules for distributing 29 day and 30 day months in such a fashion that the number of elapsed days can also be recovered. Perhaps the most famous scheme of this kind was the one elaborated by the Greek astronomer Meton. He found that 19 tropical years and 235 lunations are very nearly equal to 6940 days and this period of time is named the Metonic cycle in his honor.[1]

In other calendars the Moon is neglected and the year is made up of 12 formal months of 30 days each plus 5 days, making a total of 365 days. In this case the problem of intercalation is simply one of inserting enough days as the years go by to overcome the excess of the tropical year over the calendar year. Perhaps the most accurate arrangement to meet this difficulty was reached by Omar Khayyam and other Persian astronomers, but most persons are better acquainted with the intercalary schemes of Julius Caesar and Pope Gregory. Still another series of calendars, especially those of Assyria, India and China, are controlled by zodiacs and these sometimes yield sidereal years differing from synodic years by the slight amount of the precession of the equinox.

But intercalation is not necessary to good calendar making. The months of a calendar not corrected by intercalation are not fixed in the year but move slowly around the year. The Arabs have an uncorrected calendar of 12 lunations and the months complete the round of the seasons in about 33 years. The ancient Egyptians maintained for thousands of years an uncorrected calendar of 365 days, the months of which receded much more slowly and made a backward round of the season in 1507 years.[2] They seem to have thought that only 1460 years were necessary to effect this change, being led astray by a faulty coordination of the rising of the Nile with the heliacal rising of Sothis or Sirius. The Nile floods in accordance with the tropical year and Sirius, if we neglect his small proper

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[1]The period of 6940 days was independently reached by the Chinese and the Mayas, neither following the Greek scheme of intercalating months.

[2]The Mayas used the equation 1508 calendar years ($29 \times 52 \times 365 = 550420 = 1507$ tropical years, several examples of which will be given as we proceed.

motion, rises in accordance with the sidereal year which is some 20 minutes longer than the cycle of the solstices and equinoxes.

It is now pretty generally admitted that the calendar year of the Mayas and other civilized nations of Middle America was also a vague year of 365 days, uncorrected by intercalations, in spite of the fact that the amount of error was very nicely calculated. The Maya months therefore receded through the year of nature—and of our own corrected calendar—at a rate corresponding to our leap year intercalations. Indeed it is practically certain—and this is the gist of the present demonstration—that all the varieties of calendars possessed by the Mayas were uncorrected by intercalations or excisions. In other words the lunar calendar, the Venus calendar, the Mars calendar, etc., were all of the vague or wandering type. But the Mayas knew exactly what correction was necessary to restore the conditions which had obtained at inauguration when the calendarial places of the Moon, Venus, etc., corresponded with actual observations.[1]

Early students[2] of the Maya inscriptions made no attempts to find historical settings for the Venus and Lunar calendars or even to express the Maya dates and designations in the inscriptions and manuscripts in terms of Julian or Gregorian time. They merely examined the various tables as absolute arrangements of mean intervals of planetary motions cast in the mould of the Maya day count and its collateral permutations. Professor Robert W. Willson,[3] late astronomer at Harvard, was the first to approach the astronomical records as a truly historical problem. He studied various schemes of planetary configurations and eclipse intervals suggested by calculations in the Dresden Codex in the hope of finding astronomical bases for a correlation of ancient Maya dates and European chronology. He proceeded on the natural but mistaken supposition that the dates in this Maya manuscript connected with the tables of Venus and the Moon were necessarily those when these heavenly bodies occupied signifi-

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[1]Although the Mayas did not correct their civil calendar they developed several ways of calculating the correction. For instance they noted that 70 tuns were very close to 69 tropical years (error about 1.37 days). They then found that if they took this period three times (210 tuns = 207 years) and dropped a tun from one side of the equation and a year from the other, that the resulting 209 tuns = 206 tropical years was very close indeed. At Chichen there may be two applications of this, as follows:

Akab'tcib, Lintel					
11- 1-11- 0- 0,	12 Ahau	13 Tzec,	Mar. 9,	995	A. D.
10- 9- 0- 0					
11-12- 0- 0- 0,	8 Ahau	3 Mol,	Mar. 9,	1201	A. D.
Nunnery, Lintels					
11- 0-11- 0- 0,	1 Ahau	13 Yax,	June 22,	975	A. D.
10- 9- 0- 0					
11-11- 0- 0- 0,	10 Ahau	3 Mac,	June 22,	1181	A. D.

The second example is doubtful.

[2]I refer here especially to Ernst Förstemann whose *Commentary on the Dresden Codex* has been translated in Pap. Peabody Museum, IV, No. 2, pp. 48-266, 1906, and to Charles P. Bowditch whose *The Numeration, Calendar Systems and Astronomical Knowledge of the Mayas* appeared in 1910.

[3]A posthumous paper *Astronomical Dates in the Dresden Codex* Pap. Peabody Museum, IV, No. 3, Cambridge, 1924.

cant positions in relation to the Earth and the Sun. Mr. Teeple and Mr. Thompson in more recent papers have made the same assumption.

In the present thesis the Venus and Lunar calendars are presented as formal patterns of mean motions uncorrected from an historical time of inauguration. At this time of inauguration the calendarial positions coincided with the actual positions but as time went on the calendar positions drew away from the actual positions in the same manner as the months of a vague year necessarily draw away from their original stations. The rate of departure depends, of course, on the amount of error in the particular pattern of mean motions.

It will be demonstrated, moreover, that the true positions of Venus and the Moon were also noted after divergence had taken place, especially when significant phases coincided with round numbers in the day count, with important points in the tropical year or with leading positions in the calendars of other planets. Many Maya dates have a double or even a triple significance leading us to the conclusion that Maya astronomy had its astrological uses.

The Natural Basis of the Venus Calendar

The problem which the Mayas solved out of the appearances of the planet Venus was vastly different from that of measuring the tropical year. The natural cycle of the year, recognized by the most barbarous tribes of men, is indicated by changing aspects of nature, during the alternation of the seasons, as well as by the swinging of the points of sunrise across the east and west line of the equinoxes. Also the rising or setting of fixed stars and constellations in certain combinations with the Sun can be used by primitive peoples to give the length of the year since the year of the stars differs by an unappreciated 20 minutes from that of the seasons.

But Venus is one of several wanderers along the starry road of the zodiac and her course is hard to follow. Today with the explanation of Copernicus and the scientific plotting of orbits we understand the apparent movements of Venus as viewed from our whirling Earth. But we still make poetic use of Lucifer and Hesperus for the double life of Venus which the early Greeks thought corresponded to distinct heavenly bodies.

At the beginning of a typical career Venus appears faintly in the east just before sunrise, and the point nearest to the Sun where she can be seen by the unaided eye is called the heliacal rising. Then at increasingly earlier risings she reaches a state of glowing brilliancy before the morning dawn. Really at this time Venus is a crescent, but so near the Earth that she exposes a larger apparent area of illumination than when she is disk-shaped in a distant part of her

orbit. The luster does not last, for Venus grows smaller and dimmer as she swings on her orbit away from the Earth. Reaching the greatest elongation or apparent distance from the Sun, the planet seems to turn again toward that central attraction. There are inconspicuous weeks during which she moves, as a diminishing orb, into the morning twilight and is lost sight of at heliacal setting as morning star. After a considerable disappearance, while passing behind the Sun at superior conjunction, Venus emerges in the evening twilight as a faint and far away luminary closely following the Sun down into the west. On successive nights Venus is higher and higher in the sky when first glimpsed after sunset. Slowly her fire kindles and she gradually becomes a brilliant spectacle standing above the ruddy bar of fallen day. Her change in motion among the stars, marked by her appearing to stand still and then to move backward, is an effect of relativity as regards the moving Earth, which Venus rapidly approaches at this part of her career. Her orbit carries her between the Earth and the Sun at inferior conjunction and she seems to plunge into the sunlight at heliacal setting as evening star. About eight days later, under the most favorable conditions, keen eyes see the morning star return to repeat the strange cycle of changes.

If the orbits of Venus and the Earth were perfect circles with the Sun at the center, and if Venus made 13 revolutions around the Sun in exactly the same time that the Earth made 8 revolutions of precisely 365 days each, the conditions of the Venus calendar of the Mayas would be realized in the heavens. Venus would then pass the Earth every one and three-fifths revolutions of the latter. Compressed in a circle, the possible points of inferior conjunction (when Venus is exactly in line between the Earth and the Sun) would be one-fifth of the circumference of a circle or 72 degrees apart and compressed in a year (although really distributed 584 days apart over 8 years) the possible dates of inferior conjunction would be one-fifth of 365 days, or 73 days, apart.

But the orbits of Venus and the Earth are both elliptical rather than circular, with that of the Earth having at the present time, more than twice the eccentricity of the orbit of Venus. Moreover the Sun is situated at a focal point of each elliptical orbit and the speed of each planet varies according to Keppler's law. Venus travels at a more even rate than the Earth each, however, moving fastest when nearest the Sun and slowest when most distant. Venus gains least on the Earth in December and January with the result that an apparent revolution of the planet covering two winters and one summer may consume slightly more than 588 days while one falling in the opposite order may take slightly less than 580 days. The apparent revolutions, which are essentially laps gained on the Earth, are calculated by modern astronomers between inferior conjunctions, but the Mayas generally measured them from the heliacal

risings of the planet as morning star, about four days after inferior conjunction. This gives a period of obscuration of the planet between heliacal setting as evening star and heliacal rising as morning star of 8 days which is a practical minimum explained by the short twilight of the tropics where the Sun sets vertically. On the other hand the Mayas allowed 90 days for the obscuration at superior conjunction when the planet was in her least interesting phases.

How the Mayas Formalized the Venus Ephemeris

The Venus calendar of the Dresden Codex, pages 46 to 50 of Förstemann's numbering, to which page 24 is introductory, is a permutation of the 260 days of the tzolkin in combination with the 365 days of the haab or civil year, and the 584 days of the average synodical revolution of Venus. The pattern of intervals is repeated three times with identical days but different month positions. This table is an outgrowth of the observed correspondence between 8 years and 5 revolutions of Venus when the years are counted as 365 days, although really about 365.24 days and the Venus revolutions at 584 days, although averaging 583.92 days. The complete permutation is $65 \times 584 = 104 \times 365 = 146 \times 260 = 37{,}960$ days. With an intercalation system it would be necessary to interpolate 25 days into the annual calendar to overcome the shortage in the formal year and in the case of the Venus calendar it would be necessary to intercalate about thirty days. Or if the uncorrected annual calendar were the base on which the correction of the Venus calendar had to be calculated, an excision of five days would be required over the permutation cycle, in accordance with the following:

104	tropical years	37,985 days
104	calendar years	37,960 "
65	synodical revolutions of Venus	37,955 "

But the Mayas did not make intercalations to keep their annual calendar in accord with the seasons nor did they make excisions in their Venus calendar to make it agree in turn. Both the annual and the Venus calendars started flush with the celestial record at the time of their historical inauguration and both moved as purely formal patterns across the numbered days of the Long Count and the revolving designations of the tzolkin. Also the Lunar calendar and in all probability the formal cycles based on Mars, Jupiter, Mercury and Saturn were uncorrected by actual intercalations and excisions. But methods were devised in each case, as has been said, whereby the actual positions of the heavenly bodies could be recovered from the formal record, or new starts made from historical positions which did not involve the principal of intercalation.

In the Venus table of the Dresden Codex a typical 584 day period has the following four divisions representing appearances as

morning and evening star and the superior and inferior conjunction. When the table departs from 18 Kayab as zero and advances in groups of 236, 90, 250 and 8 days, the calculation reaches 9 Zac, 19 Muan, 4 Yax and 12 Yax respectively, as is seen in the following arrangement.

Natural Divisions of One Synodical Revolution of Venus

As formalized in the Venus Calendar

0	days	18 Kayab			Heliacal Rising as Morning Star
			236	days	Duration of Morning Star
236	"	9 Zac			Heliacal Setting as Morning Star
			90	"	Invisibility at Superior Conjunction
326	"	19 Muan			Heliacal Rising as Evening Star
			250	"	Duration of Evening Star
576	"	4 Yax			Heliacal Setting as Evening Star
			8	"	Invisibility at Inferior Conjunction
584	"	12 Yax			Heliacal Rising as Morning Star

When the intervals 236, 90, 250 and 8 days, as given above, are repeated five times a return is made to the month positions 18 Kayab, 9 Zac, 19 Muan, 4 Yax and 12 Yax. This is because $5 \times 584 = 8 \times 365$, and 8×365 from any month position in the Maya uncorrected year recovers the same position. Also it will be noted that a second 8 year series begins at the identical moment when the first one ends: this being an application of the Maya principle of the zero of completion.

Typical Pattern of Month Positions

For one 8-year Period of the Venus Calendar

0	days	18 Kayab	0	days	Heliacal Rising—Period Begins
236	"	9 Zac	236	"	
326	"	19 Muan	90	"	
576	"	4 Yax	250	"	Heliacal Setting
584	"	12 Yax	8	"	Heliacal Rising, 2nd Rev. Begins
820	"	3 Zotz	236	"	
910	"	13 Mol	90	"	
1160	"	18 Uo	250	"	Heliacal Setting
1168	"	6 Zip	8	"	Heliacal Rising, 3rd. Rev. Begins
1404	"	2 Pax	236	"	
1494	"	7 Pop	90	"	
1744	"	17 Mac	250	"	Heliacal Setting
1752	"	5 Kankin	8	"	Heliacal Rising, 4th Rev. Begins
1988	"	16 Yaxkin	236	"	
2078	"	6 Ceh	90	"	
2228	"	11 Xul	250	"	Heliacal Setting
2336	"	19 Xul	8	"	Heliacal Rising, 5th Rev. Begins
2572	"	15 Cumhu	236	"	
2662	"	0 Tzec	90	"	
2912	"	10 Kayab	250	"	Heliacal Setting
2920	"	18 Kayab	8	"	Heliacal Rising—Period Ends.

The cycle might stop here were it not for the use of designated days in the various month positions. When the pattern departing

from the month 18 Kayab is made also to depart from a day 1 Ahau occupying that position, the intervals of 236, 90, 250 and 8 days are found to lead to the following positions in the tzolkin counting from 1 Ahau:

PATTERN OF DAYS IN AN 8-YEAR PERIOD OF THE VENUS CALENDAR

First Venus Rev.	+236= 3 Cib	+90= 2 Cimi	+250=5 Cib	+8=13 Kan
Second " "	+236= 2 Ahau	+90= 1 Oc	+250=4 Ahau	+8=12 Lamat
Third " "	+236= 1 Kan	+90=13 Ix	+250=3 Kan	+8=11 Eb
Fourth " "	+236=13 Lamat	+90=12 Eznab	+250=2 Lamat	+8=10 Cib
Fifth " "	+236=12 Eb	+90= 9 Ik	+250=1 Eb	+8= 9 Ahau

The next series of tzolkin positions count from 9 Ahau with which this layout ends: the same days are reached but with different coefficients and the permutation does not exhaust itself until 13 changes have been run through, making the round of Venus calendar equal 65 × 584 or 104 × 365 or 37,960 days.

The Venus table of the Dresden Codex is shown on five pages. The upper half of each page is given over to a picture with a block of hieroglyphs above and preceded by four columns of day signs which are intended to be read in rows across the five pages. Each column consists of 13 repetitions of the same day sign but with varying numerical coefficients, and the table as a whole exhausts the 104-year permutation cycle explained above. The last glyph in the last column of the fifth page is 1 Ahau which is the end or culmination of the table and which also must be imagined as the concealed beginning.

The lower half of each page has two more pictures on the right hand side arranged directly under the top picture and each explained by a block of hieroglyphs. These two pictures are supposed to represent the gods which preside over the five Venus years, the middle pictures are warring gods and the bottom pictures are gods which have been "killed." In other words an astrological pattern is involved which we find reflected in various codices of southern Mexico.[1]

On the left hand side of the lower half of each page we find a block of four columns of five glyphs. The top row in each case consists of month signs, the second row consists of zero or completion signs, the third row of hieroglyphs of the cardinal points, the fourth row of the symbols of gods, etc., differing in each case, while the fifth and bottom row consists of Venus symbols. Under this passage are numbers which furnish a cumulative account of the Venus intervals beginning with 236 and ending on the fifth page with 2920.

The bottom glyph blocks consist of 4 columns of 5 or 6 glyphs each. The first row and last are two series of month signs; other rows give the hieroglyphs of gods, the symbols of the four directions,

[1] See E. Seler *Die Venusperiode in den Bilderschriften der Codex Borgia-Gruppe* in Gesam Abh. I, pp. 618-667. Berlin, 1902.

etc. Finally at the bottom in red numerals we find the numbers 236, 90, 250 and 8 repeated on each page.

The three rows of month signs are three locations for the day signs, or three Venus calendars departing from the following positions, Top row, 1 Ahau 13 Mac; Middle row, 1 Ahau 18 Kayab; Lower row, 1 Ahau 3 Xul. I believe the middle row is the Venus calendar, par excellence, and in the following table call it Calendar A. The top row I call Calendar B and the lower one Calendar C. Before going into further analysis I put the complete pattern of month positions before the reader:

Month Positions in Venus Table—Dresden Codex

Terminal Dates of Divisions in Formal Synodic Revolutions Corresponding to Heliacal Risings and Settings of Venus

	Morning Star 236 days Hel. Setting I	Superior Conj. 90 days Hel. Rising II	Evening Star 250 days Hel. Setting II	Inferior Conj. 8 days Hel. Rising I
Page 46				
B	4 Yaxkin	14 Zac	19 Tzec	7 Xul
A	8 Zac	18 Muan	4 Yax	12 Yax
C	19 Kayab	4 Zotz	14 Pax	2 Kayab
Page 47				
B	3 Cumhu	8 Zotz	18 Pax	6 Kayab
A	3 Zotz	13 Mol	18 Uo	6 Zip
C	13 Yax	3 Muan	8 Chen	16 Chen
Page 48				
B	17 Yax	7 Muan	12 Chen	0 Yax
A	2 Muan	7 Pop	17 Mac	5 Kankin
C	7 Zip	17 Yaxkin	2 Uo	10 Uo
Page 49				
B	11 Zip	1 Mol	6 Uo	14 Uo
A	16 Yaxkin	6 Ceh	11 Xul	19 Xul
C	6 Kankin	16 Cumhu	1 Mac	9 Mac
Page 50				
B	10 Kankin	0 Uayeb	5 Mac	13 *Mac**
A	15 Cumhu	0 Tzec	10 Kayab	18 *Kayab**
C	0 Xul	10 Zac	15 Tzec	3 *Xul**

*These are the final dates which must also be regarded as the suppressed beginning dates.

Placing the Venus Tables in Actual Chronology

The Dresden Codex, although reflecting the science of astronomy developed during the brilliant First Empire of the Mayas, is itself a product of later time. Since, however, it fails to exhibit the features in art and ceremony introduced into Yucatan by the Toltecs, we may date its original compilation before 1200 A. D., or at the latest, shortly after this date. Perhaps Calendar B is intended to be used contemporaneously. The latest date in the Dresden Codex, clearly stated by the Long Count method, is 10·19· 6· 1· 8, 12 Lamat 6 Cumhu, November 28, 950 A. D. from which an indicated subtraction of 8 days is made, leading to the date 10·19· 6· 1· 0, 4 Ahau

18 Kayab, November 20, 950 A. D.[1] This date coincides exactly with an heliacal rising of Venus as morning star[2] four days after inferior conjunction with the Sun on Julian Day 2,068,360.

From this contact Calendar A, beginning with 1 Ahau 18 Kayab, can be restored as follows:

10-18- 9-15- 0, 1 Ahau 18 Kayab,	Nov. 24, 934 A. D.
Maya Day 1,573,140 = Julian Day	2,062,524
Inferior conjunction of Venus, J. D.	2,062,521.2

Calendar B has its setting in history as follows:

11-13- 6-12- 0, 1 Ahau 13 Mac.	June 21, 1227 A. D.
Maya Day 1,680,000 = Julian Day	2,169,384
Inferior conjunction of Venus, J. D.	2,169,377.5

Here the adjustment may seem at first glance somewhat defective, but note the fact that the Maya day is a round number in the decimal system and that the summer solstice is reached. Other points in regard to this position will receive later comment.

Calendar C in the following historic location gives an exact coincidence with inferior conjunction for about the same epoch as Calendar B.

11-13- 0- 3- 0, 1 Ahau 3 Xul,	Jan. 23, 1221 A. D.
Maya Day 1,677,660 = Julian Day	2,167,044
Inferior conjunction of Venus, J. D.	2,167,044.5

One Venus round earlier (104 × 365 days) will find the planet still in the phase of evening star, 6 days before inferior conjunction (J. D. 2,129,090.2) and therefore very close to heliacal setting, while a Venus round later the planet is morning star 5 days after inferior conjunction as follows:

11-13- 0- 3- 0, 1 Ahau 3 Xul,	Jan. 23, 1221 A. D.
5- 5- 8- 0	
11-18- 5-11- 0, 1 Ahau 3 Xul,	Dec. 29, 1324 A. D.
Maya Day 1,715,620 = Julian Day	2,205,004
Inferior conjunction of Venus, J. D.	2,204,998.7

I also give at this time the historical location of a Venus calendar departing from a fourth date, 1 Ahau 18 Uo, emphasized on page 24 of the Dresden Codex, the preface to the Venus table: here the coincidence is perfect since the date reached for the heliacal rising is exactly 4 days after the inferior conjunction of Venus with the Sun.

11- 8- 7-13- 0, 1 Ahau 18 Uo	Dec. 12, 1129 A. D.
Maya Day 1,645,380 = Julian Day	2,133,764
Inferior conjunction of Venus, J. D.	2,133,760.1

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[1] This date is found in the preamble to the Lunar table but is doubtless a cross reference to Venus even as we shall see cross references to the Moon in the preamble of the Venus Table.

[2] I calculate the heliacal risings from data in a ms. *Dates of the Inferior Conjunctions of Venus* 181 *A. D. to* 1527 *A. D.* by R. W. Willson.

References to Venus in Ancient Inscriptions

It might be argued, if the Dresden Codex were the only source of information concerning the Venus calendar that this was a late invention. But references to Venus are also found in the ancient inscriptions. Indeed there are several categories of references and I therefore begin with a few statements which seem beyond cavil.

On Block 6 of the Hieroglyphic Stairway at Naranjo we see the date 7 Akbal 16 Muan, at the top of the block (Glyphs B and C1), which is tied by a distance number, in Glyph B3, to a second date, 1 Ahau 8 Kayab, in Glyph C3. At the right of the

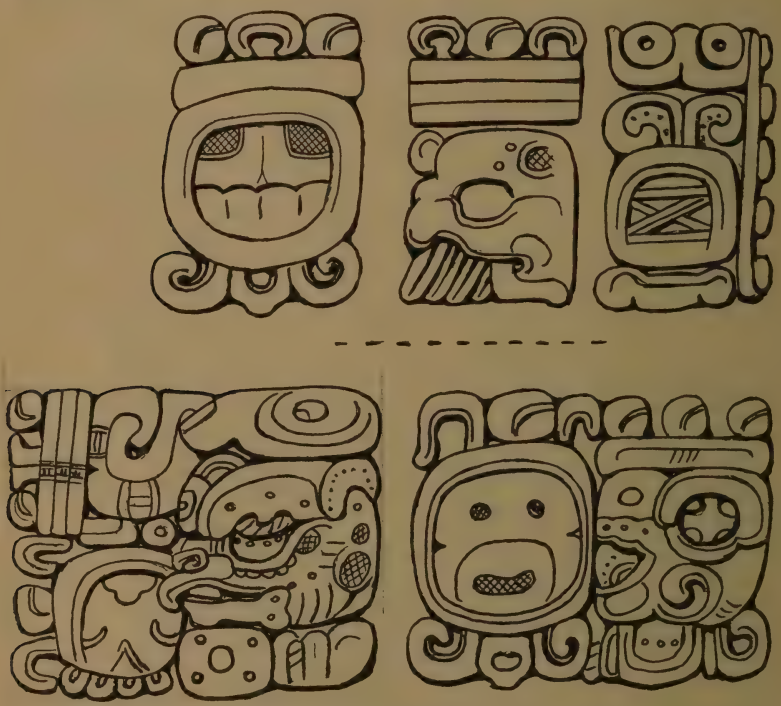

FIG. 1. PASSAGE ON THE HIEROGLYPHIC STAIRWAY AT NARANJO.

The first date falls on an heliacal rising of Venus and following it comes a symbol of Venus over that of the Ceremonial New Fire. In the lower section a distance number reaches a second date that is a round number.

first date is a very clear Venus sign, of the same type as those of the Dresden Codex, over a symbol which I have elsewhere discussed as a sacred fire bundle.[1] In the Long Count these dates are placed as follows:

9· 9·18·16· 3, 1· 1·17	7 Akbal 16 Muan,	Feb. 26,	372 A. D.
9·10· 0· 0· 0,	1 Ahau 8 Kayab,	Mar. 30,	373 A. D.

[1] See *Reduction of Mayan Dates*, p. 202.

The first of these dates, to which the Venus symbol is attached, equals Maya Day 1,367,603 and adding 489,384, the constant difference between the Maya Day and the Julian Day, we get 1,856,987 and are gratified to find that an inferior conjunction of Venus with the Sun took place on J. D. 1,856,983.0 so that the Maya statement undoubtedly refers to the heliacal rising of Venus 4 days after inferior conjunction in accordance with the allowance of the Dresden Codex. Perhaps a new ceremonial fire was lighted on this occasion.

We find a similar ceremonial fire recorded on Stela 23 at Naranjo in connection with the date 6 Ahau 13 Muan which is declared to be the end of Katun 14. This is:

9-14- 0- 0- 0, 6 Ahau 13 Muan, Feb. 4, 452 A. D.

This number reduces to J. D. 1,886,184 and we find that an inferior conjunction of Venus took place five days before on J. D. 1,886,179. In other words here was an heliacal rising of Venus coinciding with the terminal day of a major round number in the day count. Now there is no Venus symbol of the type known from the Dresden Codex in the passage we have just examined but if we turn to Stela C at Copan, where the same katun ending is declared, we do find a clear case of the usual Venus sign. In connection with this symbol we get the following remarkable subtraction:

9-14- 0- 0- 0, 6 Ahau 13 Muan, Feb. 4, 452 A. D.
11-14- 5- 1- 0
10-19-14-17- 0, 6 Ahau 18 Kayab, Apr. 12, 4165 B. C.

The true inwardness of this subtraction into the distant past does not appear until we consider the Moon. But it will be seen that the month position 18 Kayab, emphasized in the Dresden Codex is recorded here and that it falls on April 12 in the natural year. Now it happens that on page 24 of the Dresden Codex, the page that by proper numbering should come just before the Venus table of pages 46-50, that the following date is recorded:

9- 9- 9-16- 0, 1 Ahau 18 Kayab, April 12, 363 A. D.

It will be observed that we have here a combination of the Maya month position 18 Kayab and the Gregorian position April 12 just as in the distant date on Stela C at Copan. Again we must postpone for the moment our explanation and return to another clear example of the Venus symbol in combination with an accurately recorded position in the Maya Long Count.

On Stela 12 at Uaxactun 1 Ahau 3 Yaxkin is recorded in combination with the two forms of the Venus glyph found in the Dresden Codex. This date is the end of a katun, namely:

10- 3- 0- 0- 0, 1 Ahau 3 Yaxkin, July 6, 629 A. D.
Maya Day 1,461,600 = Julian Day 1,950,984.

An inferior conjunction of Venus took place about five days after

this point in time, which therefore practically coincides with the heliacal setting of Venus as evening star.

Round Numbers that Coincide with Appearances of Venus

It will be remembered that we already have had Venus records in connection with two katun endings during the period of the First Empire. Scrutinizing the likelihood of such coincidences we are sur-

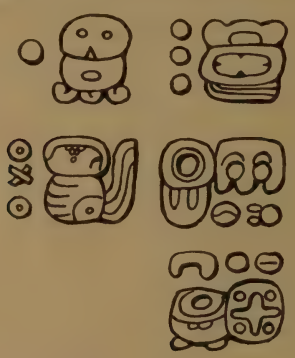

FIG. 2. INSCRIPTION ON STELA 12 AT UAXACTUN.

A round number in the Day Count which coincides with the heliacal setting of Venus.

prized to find that the interval of 3 katuns (21,600 days) is only five days less than the mean value for 37 synodical revolutions of Venus (21,605.04 days). Practically the interval fluctuates somewhat either way from this mean but the following close correspondences are noted with others less close preceding and following at intervals of 3 katuns.

9·11· 0· 0· 0, 12 Ahau 8 Ceh, Dec. 15, 392 A. D.
Maya Day 1,375,200 = Julian Day 1,864,584
Inferior conjunction of Venus, Julian Day 1,864,572.6

9·14· 0· 0· 0, 6 Ahau 13 Muan, Feb. 4, 452 A. D.
Maya Day 1,396,800 = Julian Day 1,886,184
Inferior conjunction of Venus, Julian Day 1,886,179.0

9·17· 0· 0· 0, 13 Ahau 18 Cumhu, Mar. 27, 511 A. D.
Maya Day 1,418,400 = Julian Day 1,907,784
Inferior conjunction of Venus, Julian Day 1,907,783.6

10· 0· 0· 0· 0, 7 Ahau 18 Zip, May 17, 570 A. D.
Maya Day 1,440,000 = Julian Day 1,929,384
Inferior conjunction of Venus, Julian Day 1,929,386.9

10· 3· 0· 0· 0, 1 Ahau 3 Yaxkin, July 6, 629 A. D.
Maya Day 1,461,600 = Julian Day 1,950,984
Inferior conjunction of Venus, Julian Day 1,950,990.3

The Inauguration of the Venus Calendar

These dates greatly enlarge our comparisons, but before going farther into the matter of the ancient records the inauguration of the Venus calendar calls for some attention. The Dresden Codex gives evidence concerning the operation of the peculiar time count from the Tenth to the Thirteenth centuries of the Christian era and the inscriptions on monuments of the First Empire give evidence of observances from the First to the Seventh centuries. But the inauguration seems to have occurred during the Sixth century before Christ.

I have elsewhere shown that the actual counting of days by the Mayas began on August 6, 613 B. C.[1] and that the civil calendar was inaugurated about 580 B.C. when 0 Pop, the astronomical new year day, coincided with the winter solstice and 0 Yaxkin, the farmer's new year day, fell on April 21. The celestial register had already covered in excess of 12,000 days, enabling the great astronomer who invented the Maya time count to formulate the year at 365 days. He may have observed that a bright star made its first appearance in the east just before sunrise five different times during a term of 8 years, once in pretty close adjustment with the farmer's new year. It would, however, have taken a life time or more to check and recheck the phenomena and reduce the somewhat variable data to a calendarial pattern. The heavy emphasis placed on April 12, November 17, the summer solstice, etc., in combination with the Maya month positions 19 Xul, 18 Kayab, 12 Yax, etc., leads one to place the inauguration of this special planetary calendar between 540 and 530 B. C. I give in A of the following table a set of eight heliacal risings of Venus, calculated at 4 days after inferior conjunction,[2] and in B the necessary warping to comply with the formalities of the calendar. Only 5 of these heliacal risings are necessary to form a minor round.

Original Setting of the Venus Calendar

A. *Heliacal Risings of Venus.*

7- 3-12-13- 4,	12 Kan	2 Yaxkin	Apr. 15,	541 B. C.
1-11- 2	(582.4 days)			
7- 3-14- 6- 6,	9 Cimi	19 Kayab	Nov. 17,	540 "
1-11- 3	(583.1 days)			
7- 3-15-17- 9,	7 Muluc	12 Yax	June 23,	538 "
1-11- 7	(586.6 days)			
7- 3-17-10-16,	9 Cib	9 Zip	Jan. 30,	536 "
1-11- 0	(580.1 days)			

[1] This is the round number written 7-0-0-0-0, 10 Ahau 18 Zac; the Mundane era of October 14, 3373 B. C. was reached by counting back 7 baktuns to a zero date written 13-0-0-0-0, 4 Ahau 8 Cumhu. The third Maya era, that of the Chronicles, so-called, departs from 9-0-0-0-0, 8 Ahau 13 Ceh, February 10, 176 A. D.

[2] I reach these dates by a specially constructed Venus table based on coincidence of a Venus phase and the same point in the tropical year (error about .37) in 251 years.

7· 3·19· 3·16,	4 Cib	4 Kankin	Sept. 2,	535 "
1·11· 8	(587.4 days)			
7· 4· 0·15· 4,	7 Kan	2 Yaxkin	Apr. 13,	533 "
1·11· 2	(582.2 days)			
7· 4· 2· 8· 6,	4 Cimi	19 Kayab	Nov. 15,	532 "
1·11· 3	(583.3 days)			
7· 4· 4· 1· 9,	2 Muluc	12 Yax	June 21,	530 "

B. *Calendarial Positions of Venus.*

7· 3·12·13· 1,	9 Imix	19 Xul	Apr. 12,	541 B. C.
1·11· 4	(584 days)			
7· 3·14· 6· 5,	8 Chicchan	18 Kayab	Nov. 16,	540 "
1·11· 4	(584 days)			
7· 3·15·17· 9,	7 Muluc	12 Yax	June 23,	538 "
1·11· 4	(584 days)			
7· 3·17·10·13,	6 Ben	6 Zip	Jan. 28,	536 "
1·11· 4	(584 days)			
7· 3·19· 3·17,	5 Caban	5 Kankin	Sept. 3,	535 "
1·11· 4	(584 days)			
7· 4· 0·15· 1,	4 Imix	19 Xul	Apr. 10,	533 "
1·11· 4	(584 days)			
7· 4· 2· 8· 5,	3 Chicchan	18 Kayab	Nov. 14,	532 "
1·11· 4	(584 days)			
7· 4· 4· 1· 9,	2 Muluc	12 Yax	June 21,	530 "

Common foci must be found for positions in the tropical year (as expressed in the backward projection of our Gregorian calendar), positions in the Maya year that figure in the Venus calendar, and the actual days when Venus rose in proximity to the Sun as morning star. The exigencies give, after all, little leeway. Three movements made at different rates must be carried back till all are even. Now the natural year advances in a cycle of 365.24 days, while the Maya year advances in a cycle of 365 days and Venus at a rate that reduces to 364.95 days. In 243, or better yet 251 years, the phases of Venus return to the same times in the tropical year. Thus if April 12 serves to mark a significant phase of the planet in 541 B. C., the same phase will repeat on April 12, 290 B. C.; April 12, 39 B. C.; April 12, 212 A. D., etc. The adjustment is not quite perfect but is near enough for general purposes. In this interval of 251 years Venus recedes about 12 days in the Maya year and the Maya year recedes about 61 days in the tropical year. The coincidence can no longer take place on 19 Xul but instead on 7 Xul and this 7 Xul is located 73 days, or one-fifth of a year in recession from the original status of 19 Xul.

The reader will remember that the first two series of month signs in the Venus calendar of the Dresden Codex are as follows for the phase of heliacal rising:

Calendar A	12 Yax,	6 Zip,	5 Kankin,	19 Xul,	18 Kayab.
Calendar B	7 Xul,	6 Kayab,	0 Yax,	14 Uo,	13 Mac.

In 251 years, or 157 synodic revolutions of Venus, the month lists are run over 31 times plus two additional revolutions. When, there-

fore, the positions of Calendar B are shifted forward these two extra revolutions we have an arrangement not disturbing the sequence but disclosing the difference of 12 days which is the essential recession of the appearances of the planet, in terms of the Maya year, for an interval of 251 years; thus:

Calendar A	12 Yax,	6 Zip,	5 Kankin,	19 Xul,	18 Kayab.
Calendar B	0 Yax,	14 Uo,	13 Mac,	7 Xul,	6 Kayab.

That Calendar B of the Dresden Codex restores the allignment between the Maya year and the actual positions of Venus after Calendar A has been in operation for about two and a half centuries may be seen from an examination of the historical positions given above. The search for a special day, 1 Ahau, limited the choice of beginnings to 1 Ahau 18 Kayab for Calendar A and 1 Ahau 13 Mac for Calendar B and slightly distorted the adjustment from its maximum accuracy. The normal succession might be better expressed by adding the interval in the following fashion:

10-19- 6- 1- 0, 12-14-11-17	4 Ahau	18 Kayab,	Nov. 20, 950 A.D.	Heliacal Rising of Venus
11-12- 0-12-17,	4 Cib	14 Uo,	Nov. 20, 1201 A.D.	Heliacal Rising of Venus

If the system indicated in these two calendars is carried to its logical conclusion the original month positions of Calendar A are recovered in $6 \times 251 = 1506$ years. This is just a year less than the major cycle of the Maya civil year in which 29 calendar rounds or 1508 civil years are found to equal 1507 tropical years. In other words if Venus appeared as morning star on 19 Xul and April 12 in 541 B. C. she would appear, according to rule, again on 19 Xul and April 12, 1506 years later, thus:

Heliacal Risings by Calendar			Julian Days	Actual Inf. Conj.
7- 3-12-13- 1,	9 Imix 19 Xul,	Apr. 12, 541 B.C.	J.D. 1,523,565	1,523,564.3
3-15- 8-17- 0,	(29 calendar rounds)		550,420	
11- 0- 1-12- 1,	9 Imix 19 Xul,	Apr. 12, 966 A.D.	J.D. 2,073,985	
1- 0- 5,	(1 civil year)		365	
11- 0- 0-11-16,	8 Cib 19 Xul,	Apr. 12, 965 A.D.	J.D. 2,073,620	2,073,616.9

The time required for 942 synodical revolutions of Venus is 550,052.6 days or about two days over the calendarial allowance.

The full pattern of the Venus calendar is embodied in the following table: and it will be noted that the recovery of Calendar A after Calendar F is made by allowing a recession of 13 instead of 12 days for the last offset.

TABLE SHOWING OFFSETS OF THE VENUS CALENDAR

	Apr. 12	Nov. 16	June 23	Jan. 28	Sept. 3
A	19 Xul	18 Kayab	12 Yax	6 Zip	5 Kankin
B	0 Yax	14 Uo	13 Mac	7 Xul	6 Kayab
C	1 Mac	15 Tzec	14 Pax	8 Chen	2 Uo

D	2 Pax	16 Mol	10 Pop	9 Ceh	3 Tzec
E	3 Uayeb	17 Zac	11 Zotz	10 Muan	4 Mol
F	19 Zip	18 Kankin	12 Yaxkin	11 Cumhu	5 Zac
A	19 Xul	18 Kayab	12 Yax	6 Zip	5 Kankin

The use of a complete cycle of 1506 years may be inferred from the important date in the Lunar table which places Calendar A in its proper historical setting. But there is no evidence that Calendar A was ever really supplanted except for purposes of easy calculation. The only month positions in the Maya year that seem to have a ceremonial significance in what may be called the Venus cult are 19 Xul, 18 Kayab, 12 Yax, 6 Zip and 5 Kankin or the nearest positions to these which can be occupied by round numbers. Since 18 Kayab is the only one that can be occupied by a round number it becomes the outstanding date. The important approximations are 18 Xul, 13 Yax, 3 or 8 Zip and 3 or 8 Kankin.

Hieroglyphs of Venus

There are several hieroglyphs of the planet Venus perhaps representing different aspects. Two forms common to the inscrip-

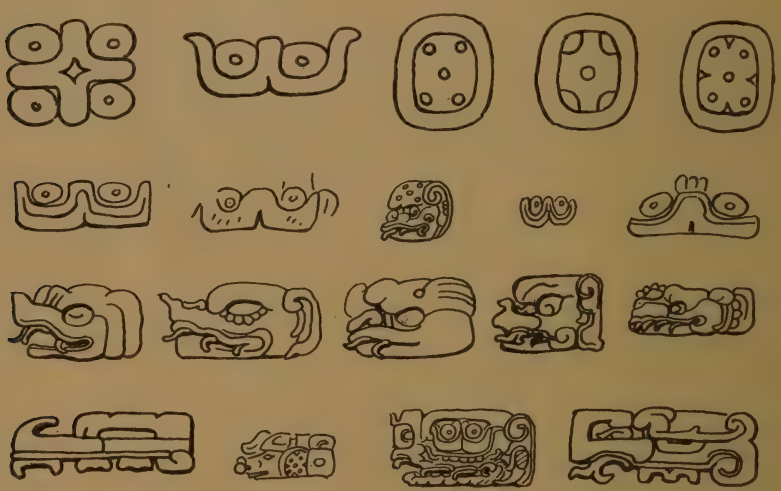

Fig. 3. Venus Glyphs.

First line: simple Venus glyphs. Second, third and fourth lines: Venus titles in the introducing glyphs of Initial Series.

tions and the codices, have long been accepted by Mayan students. The first of these accepted symbols of Venus may be described as a pair of circles held in an ornamental bracket. The second one seems, in some cases, merely to be the first symbol doubled over on itself. It consists of four circles arranged in a rectangle, and there is a fifth space in the center where the notch in the first bracket is backed against the notch in the second.

Lamat was, par excellence, the day of Venus, why, I am not able to say. The hieroglyph of this day is generally a somewhat specialized type of the second Venus symbol, but on occasion the first sign of Venus is used, or even a grotesque face, also representing the planet. This face, not previously recognized as a hieroglyph of Venus, belongs to a creature which I have ventured to call the Venus Monster. It is the front head of the grotesque double-headed creature to which Maudslay gave the name Two-Headed Dragon. This front head of the Two-Headed Dragon contains the Venus symbol in the eye or prominently attached to the ear ornament. I have elsewhere examined the symbolism of the Two-Headed Dragon (A Study of Mayan Art, pp. 53-56) and suggested that it was related in some fashion to calamities of flood and drought. It now appears that these calamities were awaited with dread at the times of the eight day obscuration of Venus at inferior conjunction with the Sun. The rear head of the double monster carries the Sun symbol and the front head carries the Venus symbol. Bones and other signs of death are applied to the heads as well as streams of water and the elongated body is sometimes converted into a band of celestial symbols possibly intended to represent the firmament.

Among the hieroglyphs for Venus which I have been able to recognize through repeated association with dates of Venus significance is a cartouche with five dots, one in the center and one near

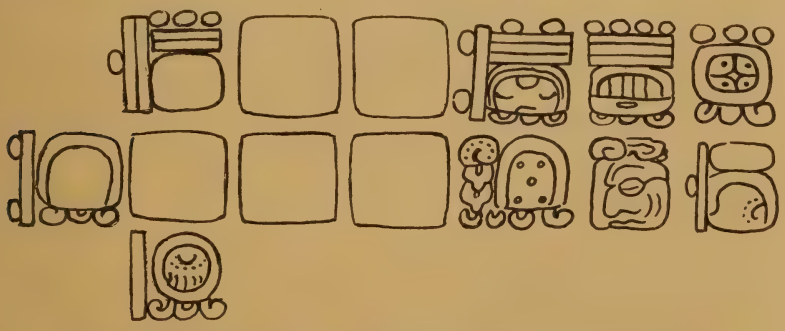

FIG. 4. PASSAGE ON LINTEL 4 AT PIEDRAS NEGRAS.
Date of Venus coincidence in combination with two other significant dates.

each of the four rounded corners. These five dots probably refer to the five Venus revolutions of an eight year period. Sometimes the Venus Monster wears these five dots on his forehead. Also the double type of Venus hieroglyph in the codices and the Lamat variation embody the idea of five markings, one being in the center while the others are ranged about it in a rectangular formation. Sometimes this last Venus symbol is combined with the kin or sun sign in a device that may represent the conjunction of Venus with the Sun.

Other References to Venus in Ancient Inscriptions

It is now possible to give a series of other references to Venus in which these newly-recognized hieroglyphs are used. The glyph with the five dots is found in connection with the final passage on Lintel 4 of Piedras Negras which I render as follows:

9-10- 5- 6-10, 13-11	7 Oc	8 Zotz,	July 12,	378 A. D.
9-10- 6- 2- 1, 19-17- 7	5 Imix	19 Kayab,	Apr. 9,	379 A. D.
9-11- 6- 1- 8,	3 Lamat	6 Chen,	Oct. 13,	398 A.D.

Here the first date coincides with an inferior conjunction of Venus on J. D. 1,859,314.7, the second reaches April 9 of the astronomical base line at Copan and the last is a true anniversary of the Mundane era. Perhaps also there are lunar conformities.

Stela A at Copan. The Initial Series of Stela A at Copan exactly records the day of an inferior conjunction of Venus and the text contains Venus glyphs. This important inscription can be written as follows:

9-14-19- 8- 0,	12 Ahau	18 Cumhu,	Apr. 5,	471 A. D.
3- 0	subtract			
9-14-19- 5- 0,	4 Ahau	18 Muan,	Feb. 4,	471 A. D.
	* * *			
9-15- 0- 0- 0,	4 Ahau	13 Yax,	Oct. 22,	471 A. D.
	* * *			
9-15- 0- 3- 0,	12 Ahau	13 Mac,	Dec. 21,	471 A. D.

Here the first date is the conjunction of Venus on Julian Day, 1,893,185.2 and from it additional statements can be drawn. First, April 5 is the original date reached by the astronomical base line at Copan, April 9, the date of the heliacal rising after the recorded conjunction, is the second setting of the base line, while 0 Pop, the Maya new year day, follows in three days on April 12, the last and present setting of the base line, and a date, moreover, that is especially emphasized in relation to Venus. The inscription of Stela A must be considered in relation to several others. The subtraction of 3 uinals to reach 4 Ahau 18 Muan on February 4 gives a date also important on Stela C and Altar U. It is one Metonic cycle after the Venus coincidence on 9-14- 0- 0- 0, 6 Ahau 13 Muan, February 4, 452 A. D. The date 9-15- 0- 0- 0, 4 Ahau 13 Yax, has Venus significance because 13 Yax is an approximation of 12 Yax of the original Venus calendar, while 12 Ahau 13 Mac is the winter solstice.

Venus Calculations at Yaxchilan. Lintel 29 in Structure 10 at Yaxchilan has a very clear Venus sign in the introducing glyph of an Initial Series that renders 9-13-17-12-10, 8 Oc 13 Yax, October

27, 449 A. D. Structure 10 is a rambling building added to at different times. An earlier part has Lintels 29, 30 and 31 while a later wing has Lintels 32 and 33. The lintels of the first set are entirely glyphic and those of the second set have sculptured tableaux with human figures. The calculations on Lintels 29, 30 and 31 are obviously inter-related and they lead up to the important round number 9-17- 0- 0- 0, 13 Ahau 18 Cumhu, March 27, 511 A. D. where there was a Venus coincidence.

The Initial Series date with the Venus sign in the introducing glyph does not itself reach a significant phase of the planet but it may involve a comparison of two dates which do, namely:

7- 3-15-17- 0, 2-10- 1-13- 0	8 Oc	13 Yax,	June 24,	538 B. C.
9-13-17-12-10, 12- 1	8 Oc	13 Yax,	Oct. 27,	449 A. D.
9-13-18- 6-11,	4 Chuen	9 Zotz,	June 24,	450 A. D.

Here the first date is at the inauguration of the Venus calendar, on 13 Yax, practically coinciding with the summer solstice. This position is reached, as we see, by counting backward 19 calendar rounds from the recorded one of the initial series. The third date is that of another heliacal rising at exactly the same time in the natural year. While the two Venus dates are recovered on theoretical grounds the association with the summer solstice is ramified by another circumstance. For on Lintel 30 there is a distance number which reached a date repeated several times at Yaxchilan and always in association with a hieroglyph that means the summer solstice. This date is 9-16- 1- 0- 0, 11 Ahau 3 Tzec, July 3, 492 A. D. The same date reaches the summer solstice exactly one calendar round later. On Stelae 11 and 12 there are other calculations with dates that interlock with the dates on the lintels we have just considered.

The Venus Temples of Copan. A series of structures at Copan have to do with the coincidence of Venus with the round number 9-17- 0- 0- 0, 13 Ahau 18 Cumhu, March 27, 511 A. D. One of these is Temple 22a which Morley named the Temple of Venus because of three large Venus symbols on the inner step which carries the inscription. The principal and only clear date is the one given above and with it is a hieroglyph of a new fire ceremony. There are, however, statements of 6 Ahau and 2 Ahau which may possibly refer to the nearby katun ending days of 9-14-0-0-0, 6 Ahau 13 Muan, February 4, 452 when there was another Venus coincidence, and 9-16- 0- 0- 0, 2 Ahau 13 Tzec, July 9, 491.

Temple 11 has several associations with the Venus cult. The date on the sculptured inner step, now in the British Museum, is that of the astronomical congress, namely 9-16-12- 5-17, 6 Caban

10 Mol, September 2, 503 A. D.[1] On the doorway of the temple this date is repeated along with 9-14-15- 0- 0, 11 Ahau 18 Zac, November 17, 466, a position which seems to have received considerable attention because 18 Zac is the month position of the Historical era in the Maya year, and November 17 is the original location of 18 Kayab of the Venus calendar. The date on Stela N alligned with one stairway of this temple is 9-16-10- 0- 0, 1 Ahau 3 Zip, May 18, 501. This has some slight connection with Venus since 3 Zip is an approximation of 6 Zip of the Venus calendarial position. Stela N also declared a katun ending in the past which coincides with the winter solstice (8-17- 0- 0- 0, 1 Ahau 8 Chen, December 22, 116 A. D.) and its collar has a statement of the position in the tropical year of the Historical era, namely 9-16-13- 4-15, 6 Men 3 Yaxkin, August 6, 504 A. D., which should be considered with the anniversary of this era in the Maya year recorded on the doorway.

Temple 22 at Copan was a gorgeous edifice with high relief sculptures partly restored by Maudslay from remains still in place about the inner doorway. On either side of the doorway a stooping atlantean figure sustains one end of a grotesque two-headed Venus monster. The symbols of the planet are prominently displayed on the legs of this monster. The body consists of five horizontal S's each with a grotesque mannikin entangled in the folds and a smaller vertical S at each side. The outer doorway carried a similar decoration to judge from atlantean sculptures in the Peabody Museum of Harvard University, which are replicas of those still in place. Also the platform before the temple represents the lower jaw with teeth indicated on the upper parts of the stairway. In addition there were mask panels on the corners of the temple and probably the upper zone was a frieze of heavily sculptured gods and human beings. The high step of the inner chamber has four glyphic panels, ten glyphs to a panel, between death's heads.

Morley says that this building must be placed between the dedication of Temple 11 and Temple 22a. But both of these are in simpler style than Temple 22 and both seem, moreover, to have the same principal date, namely 9-17- 0- 0- 0, 13 Ahau 18 Cumhu, March 27, 511 A. D. I suggest therefore that Temple 22 was erected to obviate the calamities due to the coincidence of Venus at the important round date 10-0-0-0-0, 7 Ahau 18 Zip, May 17, 570.

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[1] This most important date has pretty definite relations to Venus. Not only is September 2 an original position of the Venus heliacal rising at the time the calendar was inaugurated, but in the year 503 A. D. the Maya new year day 0 Pop fell on April 5, thus:

9-16-12- 5-17, 7-10	6 Caban 10 Mol,	Sept. 2, 503 A. D.
9-16-11-16- 7,	12 Manik 0 Pop,	Apr. 5, 503 A. D.

An inferior conjunction of Venus with the Sun occurred on Julian Day 1,904,863.9 so that this new year began only three days after heliacal rising, perhaps regarded as a favorable condition.

The only recognizable time indication on the interior step of Temple 22 is the day 5 Lamat, which recurs every 260 days. However, if the date of the temple is taken to be Katun 17 rather than Baktun 10, then we might have

9·17· 0· 0· 0, 13 Ahau 18 Cumhu, Mar. 27, 511 A. D.
7· 8
9·17· 0· 7· 8, 5 Lamat 1 Mol, Aug. 24, 511 A. D.

Now this date 5 Lamat 1 Mol occurs three times on different monuments at Palenque. It is first placed three calendar rounds before the position given above and is then carried forward a great distance into the future and placed 8 days in advance of Pictun 1, thus:[1]

1·0·0·0·0·8, 5 Lamat 1 Mol, Dec. 25, 4512 A. D.
8
1·0·0·0·0·0, 10 Ahau 13 Yaxkin, Dec. 17, 4512 A. D.

Here it is associated with a new fire ceremony as will be shown later. I think it not impossible that this complex is intended in the cryptic day sign on the step of Temple 22.

Venus Monster Altars at Copan. The three altars called G^1, G^2 and G^3 are representations of plumed Venus monsters, carved on the two sides and across the edges of laminar blocks of stone. Altar G^1, the largest and most elaborate of the lot, has at one end a conventional reptile head which probably symbolizes a dead Sun, and at the other a smaller one which symbolizes a living Venus. The drawing is practically the same on the two sides of the block, and as has been said, the details carry across the edges which are treated stencil fashion. Between the terminal figures is a double column of glyphs. The larger reptile motive is an immense head with elongated and fantastic upper jaw and a short lower jaw resting upon a leg of bare bone. The lower jaw and the end of the nose also indicate death according to the Maya conventions. Seated in the open mouth of this monster is a small figure of the Sun God. The smaller, or rear head, is of the same general type but there is no death symbolism and the eyes on either side contain the Venus sign. In the open mouth is a battered head possibly intended for the Sun God.

Altar G^2 pictures a two-headed plumed serpent of symmetrical design, with the body arched and with a block of four glyphs under the arch. Altar G^3 follows the same pattern as G^2 but is somewhat smaller in size. On neither of these monuments is there any actual symbol of Venus or the Sun comparable to the ones on Altar G^1, but the subject is a mere variation on the theme of the Venus Monster and the dates have rather obvious significance in that they occur on other monuments where planetary symbolism is emphatically presented.

[1] The date 10 Ahau 13 Yaxkin is recorded in the Dresden Codex on pages 60 and 70 where the same Pictun 1 may be intended.

The time positions recorded on these three monuments are all of the period-ending type, as follows:

Altar G^3	9-16-15- 0- 0,	7 Ahau	18 Pop,	Apr. 22, 506 A. D.
	9-17- 0- 0- 0,	13 Ahau	18 Cumhu,	Mar. 27, 511 A. D.
Altar G^2	9-18- 5- 0- 0,	4 Ahau	13 Ceh,	Nov. 16, 535 A. D.
Altar G^1	9-18-10- 0- 0,	10 Ahau	8 Zac,	Oct. 20, 540 A. D.

The associations with Venus involved in the dates of Altars G^3 and G^2 are more obvious at first sight than that of Altar G^1. The portentious katun which ended while Venus was passing from evening to morning star is recorded on Altar G^3 and it will be remembered that we have already found this date emphasized in connection with the planet on several other monuments at Copan as well as at Yaxchilan.[1] Whether the third hotun of Katun 16, also recorded on G^3, had significance in the Venus cult is doubtful.

Altar G^2 deserves to be bracketed with the famous Great Turtle Altar, so-called, of Quirigua. Both are Venus monsters and both bear the same date which recovers 4 Ahau of the Mundane era, 13 Ceh of the era of the Chronicles and reaches November 16, a close approximation to the original position of 18 Kayab at the inauguration of the Venus calendar. The date is also found on Altar 2 of Cancuen and on the newly discovered Stela 12 of Piedras Negras. It is also the probable date of the three altars from Lubaantun, now in the Peabody Museum at Harvard. The sculpture following that of the altar at Cancuen pictures the building of a ceremonial fire.

The date on Altar G^1 marks the half-way stage between the culminations at 9-17- 0- 0- 0, 13 Ahau 18 Cumhu, March 27, 511 and 10- 0- 0- 0- 0, 7 Ahau 18 Zip, May 17, 570. The text on this altar contains more than one detail pointing to Venus. One glyph is a somewhat decorative full-form symbol of Venus comparable to a glyph on Altar R.

Altar W^1 at Copan is another variation on the Venus monster motive. On the face of this monolith is seen a crocodile-like front head and the rear head in the likeness of the Long-nosed God with a long jaw, while in the center of the design is a front view representation of the Sun God with the solar symbol on his forehead. The back and both ends of the monument carry hieroglyphs but the only decipherable part is the front end where a distance number 9- 4 leads from a calendar round date 6 Ahau 13 Kayab to a day 8 Kan. This addition can be put in the following chronological setting in which the calendar round date strikes the end of a hotun:

9-17- 5- 0- 0,	6 Ahau	13 Kayab,	Feb. 28,	516 A. D.
9- 4				
9-17- 5- 9- 4,	8 Kan	12 Mol,	Aug. 31,	516 A. D.

[1] The date 9-17- 0- 0- 0, 13 Ahau 18 Cumhu, March 27, 511 is recorded at Copan on Temple 21 a, the Reviewing Stand on the Pyramid of Temple 11, Altar Z and Altar G^3; at Yaxchilan on Lintel 31; at Piedras Negras on Stela 13; at Quirigua on Stela E, at Seibal on Stela 6 and at Nakun and Honradez on Stelae 7 and U respectively. In nearly every case the reference to Venus is clear.

The hotun date has some interest in connection with the Venus calendar by reason of the 13 Kayab and at this time Venus was shining her brightest as morning star. The second date suggests a correlation with the second or third setting of the astronomical base line but is not true to the exact day.

Several altars associated with stelae at Copan are of the Venus Monster type, the most conspicuous being the altar of Stela M. There are a few glyphic cartouches on the altar but none are decipherable. The only clear date on Stela M is a hotun ending without any marked reference to Venus. I believe, however, that there are additions of 2 tuns and then of 8 days leading to two dates which exactly state the heliacal setting of Venus as evening star and the heliacal rising as morning star. The whole record appears to be:

9-16- 5- 0- 0,	8 Ahau	8 Zotz,	June 12, 496 A. D.
2- 0- 0			
9-16- 7- 0- 0,	13 Ahau	18 Zip,	June 2, 498 A. D.
8			
9-16- 7- 0- 8,	8 Lamat	6 Zotz,	June 10, 498 A. D.

Other Uses of the Venus Monster Motive

The Venus Monster motive is rather widely distributed on monuments of the First Empire. As a celestial canopy it is prominent at Yaxchilan, Piedras Negras and Palenque, while at Copan and Quirigua the most striking uses are in altars. I give a list of the principal occurrences with dates and brief comment.

Yaxchilan. Stela 1: Sun, Moon and Sky God above the canopy. Ceremonial bar of the dead serpent type. Flood symbol in hand of human figure. Venus title in introducing glyph. Dates: Initial Series. 9-16-10- 0- 0, 1 Ahau 3 Zip, May 18, 501 A. D. A record of 6 Ahau may mean:

9-14- 0- 0- 0, 6 Ahau 13 Muan, Feb. 4, 452 A. D.

Stela 4: Sun, Moon and Sky God above canopy. Venus symbols attached to lower side. Flood symbol in hand of human figure. Ceremonial bar of dead serpent type. Date missing, possibly Katun 14 or Katun 17.

Stela 6: Sun, Moon and Sky God above canopy. Flood symbol in hand of human figure. Date, uncertain.

Stela 11: Sun, Moon and Sky God above canopy. Large Venus sign below canopy. Title of introducing glyph is summer solstice. Dates have marked Venus significance, 9-16- 1- 0- 0, 11 Ahau 8 Tzec, July 3, 492 A. D. becomes June 22, one calendar round ahead. An original month position of Venus calendar is found in 9-15-19- 1- 1, 1 Imix 19 Xul, August 4, 490 A. D.

Piedras Negras. Stela 6: Serpent bird above canopy, heads of monster fall down over throne, flood symbol in the mouths. Dates are approximations to 6 Zip of the Venus calendar.

Stela 11: Serpent bird above canopy, heads of monster fall down over throne, flood symbol in the mouths. Date 9-15- 0- 0- 0, 4 Ahau 13 Yax, October 22, 471. Approximation to 12 Yax of Venus calendar.

Stela 14: Serpent bird above canopy, heads of monster fall down over throne, flood symbol in the mouths. Sun symbol emphasized at either side. Two dates, one being 9-18- 0- 0- 0, 11 Ahau 18 Mac, December 12, 530 A. D.

Stela 25: Serpent bird above canopy, heads of monster fall down over throne. Two dates certain but apparently others. No Venus significance disclosed.

Stela 33. Throne apparently of celestial canopy type but in profile. Two dates but no Venus significance disclosed.

Palenque. Stucco ornament in Palace over doorway, Venus symbols on legs of monster, but no accompanying date. Also Venus Monster as headdress in Temple of Inscriptions.

Seibal. Stelae 9 and 10 have ceremonial bars which may be intended to represent the Venus Monster. The date in both cases is 10- 1- 0- 0- 0, 5 Ahau 3 Kayab, January 31, 590 A. D. which may be considered an approximation of January 28 in the original Venus calendar.

Naranjo. Stela 8 has a variation of the Venus monster as headdress of the human figure with Venus glyph over a face decorated like the God of the Number 7. The principal date is 9-18-10- 0- 0, 10 Ahau 8 Zac, October 20, 540. This is the date of Altar G^1 at Copan that is a Venus monster. Also 11 Ahau 13 Yax is recorded. This is a Venus month position, 73 tuns from Katun 15 as follows:

9-15- 0- 0- 0,	4 Ahau 13 Yax,	Oct. 22, 471 A. D.
3-13- 0- 0		
9-18-13- 0- 0,	11 Ahau 13 Yax,	Oct. 5, 543 A. D.

The calculations of this monument interlock with those of Stelae 6 and 7.

Stela 32. The throne is here concerned largely with the Venus monster motive and some of the dates are pretty clearly involved.

Tikal. Lintel 1 of Temple II. Venus Monster arched over throne. The leading date is 9-15-10- 0- 0, 3 Ahau 3 Mol, August 30, 481 A. D. and the principal concern seems to be with the base

line. 0 Pop on April 8 is lifted one day to reach April 9. But August 30 is the reciprocal date of April 12 and this is the emphatic position of the Venus calendar in the tropical year.

Quirigua. Stela H. Small celestial canopy on the back over seated figure: no Venus signs, however. The date is 9·16· 0· 0· 0, 2 Ahau 13 Tzec, July 9, 491 A. D.

Altar O. An altar in the form of the Venus Monster with the date 9·18· 0· 0· 0, 11 Ahau 18 Mac, December 12, 530 A. D. I do not know how the Venus significance is found but see Stela 14 at Piedras Negras.

Altar P. Elaborate Venus Monster, details of smoke scrolls in over-lying designs, ceremonial fire as title in Initial Series introducing glyph and elsewhere in text. Principal date 9·18· 5· 0· 0, 4 Ahau 13 Ceh, November 16, 535 A. D. This gives the Maya anniversary of the era of the Chronicles, 9· 0· 0· 0· 0, 8 Ahau 13 Ceh, February 10, 176 A. D. and November 16 is about at the original position of 18 Kayab of the Venus calendar. The elaborate glyphs of the sides of the monster symbolize Baktun 10 with the Venus coincident and a dead hand holds out four days, thus:

10· 0· 0· 0· 0, 7 Ahau 18 Zip, May 17, 570 A. D.
4
10· 0· 0· 0· 4, 11 Kan 2 Zotz, May 21, 570 A. D.

This is not sufficient, however, to reach the heliacal rising. The Mundane era and the era of the Chronicles are declared (C9b and E9) and several other dates.

Copan: see discussion above for the principal examples of the Venus monster motive.

Round Number Approximations

Round number dates are pretty clearly involved in the Venus cult when they give approximations to 18 Kayab, 12 Yax, 6 Zip, 5 Kankin and 19 Xul and to November 16, June 23, January 28, September 3 and April 12 which were astronomical positions of Venus at the time of the inauguration of the Venus calendar. For the First Empire the dates that receive such emphasis are the following.

Round Number Approximations to Original Venus Positions in the Maya Year

8·16· 0· 0· 0,	3 Ahau	8 Kankin,	Apr. 5, 97 A.D..	3 over 5 Kankin
8·16·15· 0· 0,	8 Ahau	13 Yax,	Jan. 18, 112 A.D.,	1 over 12 Yax
8·17·10· 0· 0,	13 Ahau	18 Xul,	Oct. 31, 126 A.D.,	1 under 19 Xul
8·18· 5· 0· 0,	5 Ahau	3 Zip,	Aug. 13, 141 A.D.,	3 under 6 Zip
8·19· 0· 0· 0,	10 Ahau	13 Kayab,	May 26, 156 A.D.,	5 under 18 Kayab
9· 4· 0· 0· 0,	13 Ahau	18 Yax,	Dec. 18, 254 A.D.,	5 over 13 Yax
9· 4·15· 0· 0,	5 Ahau	3 Yaxkin,	Oct. 1, 269 A.D.,	4 over 19 Xul

9- 5-10- 0- 0,	10 Ahau	8 Zip,	July 14, 284 A.D.,	2 over 6 Zip
9- 6- 5- 0- 0,	2 Ahau	18 Kayab,	Apr. 27, 299 A.D.,	exact
9- 7- 0- 0- 0,	7 Ahau	3 Kankin,	Feb. 8, 314 A.D.,	2 under 5 Kankin
9- 7-15- 0- 0,	12 Ahau	8 Yax,	Nov. 21, 328 A.D.,	4 under 12 Yax
9- 8-10- 0- 0,	4 Ahau	13 Xul,	Sept. 4, 343 A.D.,	6 under 19 Xul
9-12- 0- 0- 0,	10 Ahau	8 Yaxkin,	Sept. 1, 412 A.D.,	10 over 19 Xul
9-12-15- 0- 0,	2 Ahau	13 Zip,	June 15, 427 A.D.,	7 over 6 Zip
9-13-10- 0- 0,	7 Ahau	3 Cumhu,	Mar. 28, 442 A.D.,	5 over 18 Kayab
9-14- 5- 0- 0,	12 Ahau	8 Kankin,	Jan. 8, 457 A.D.,	3 over 5 Kankin
9-15- 0- 0- 0,	4 Ahau	13 Yax,	Oct. 22, 471 A.D.,	1 over 12 Yax
9-15-15- 0- 0,	9 Ahau	18 Xul,	Aug. 4, 486 A.D.,	1 under 19 Xul
9-16-10- 0- 0,	1 Ahau	3 Zip,	May 18, 501 A.D.,	3 under 6 Zip
9-17- 5- 0- 0,	6 Ahau	13 Kayab,	Feb. 28, 516 A.D.,	5 under 18 Kayab
9-18- 0- 0- 0,	11 Ahau	18 Mac,	Dec. 12, 530 A.D.,	7 under 5 Kankin
10- 1-10- 0- 0,	4 Ahau	13 Kankin,	Dec. 10, 599 A.D.,	8 over 5 Kankin
10- 2- 5- 0- 0,	9 Ahau	18 Yax,	Sept. 23, 614 A.D.,	6 over 12 Yax
10- 3- 0- 0- 0,	1 Ahau	3 Yaxkin,	July 6, 629 A.D.,	4 over 19 Xul

Round Number Approximations to Original Venus Positions in the Tropical Year

8-16- 0- 0- 0,	3 Ahau	8 Kankin,	Apr. 5, 97 A.D.,	7 under Apr. 12
8-18- 0- 0- 0,	12 Ahau	8 Zotz,	Sept. 8, 136 A.D.,	5 over Sept. 3
8-18-15- 0- 0,	4 Ahau	18 Cumhu,	June 22, 151 A.D.,	1 under June 23
9- 1-10- 0- 0,	5 Ahau	3 Tzec,	Sept. 7, 205 A.D.,	4 over Sept. 3
9- 2- 5- 0- 0,	10 Ahau	8 Pop,	June 20, 220 A.D.,	3 under June 23
9- 4- 5- 0- 0,	6 Ahau	13 Chen,	Nov. 23, 259 A.D.,	7 over Nov. 16
9- 5- 0- 0- 0,	11 Ahau	18 Tzec,	Sept. 5, 274 A.D.,	2 over Sept. 3
9- 5-15- 0- 0,	3 Ahau	3 Uo,	June 18, 289 A.D.,	5 under June 23
9- 7-15- 0- 0,	12 Ahau	8 Yax,	Nov. 21, 328 A.D.,	5 over Nov. 16
9- 8-10- 0- 0,	4 Ahau	13 Xul,	Sept. 4, 343 A.D.,	1 over Sept. 3
9-11- 5- 0- 0,	5 Ahau	3 Zac,	Nov. 19, 397 A.D.,	3 over Nov. 16
9-12- 0- 0- 0,	10 Ahau	8 Yaxkin,	Sept. 1, 412 A.D.,	2 under Sept. 3
9-14- 0- 0- 0,	6 Ahau	13 Muan,	Feb. 4, 452 A.D.,	7 over Jan. 28
9-14-15- 0- 0,	11 Ahau	18 Zac,	Nov. 17, 466 A.D.,	1 over Nov. 16
9-15-10- 0- 0,	3 Ahau	3 Mol,	Aug. 30, 481 A.D.,	4 under Sept. 3
9-17-10- 0- 0,	12 Ahau	8 Pax,	Feb. 2, 521 A.D.,	5 over Jan. 28
9-18- 5- 0- 0,	4 Ahau	13 Ceh,	Nov. 16, 535 A.D.,	exact
9-19- 0- 0- 0,	9 Ahau	18 Mol,	Aug. 29, 550 A.D.,	5 under Sept. 3
10- 1- 0- 0- 0,	5 Ahau	3 Kayab,	Jan. 31, 590 A.D.,	3 over Jan. 28
10- 1-15- 0- 0,	10 Ahau	8 Mac,	Nov. 14, 604 A.D.,	2 under Nov. 16

Katun Approximations to Actual Inferior Conjunctions of Venus

8-16- 0- 0- 0,	3 Ahau	8 Kankin,	Apr. 5, 97 A.D., 35 days after Inf. Conj.[1]
8-19- 0- 0- 0,	10 Ahau	13 Kayab,	May 26, 156 A.D., 31 days after Inf. Conj.
9- 2- 0- 0- 0,	4 Ahau	13 Uo,	July 17, 215 A.D., 29 days after Inf. Conj.
9- 5- 0- 0- 0,	11 Ahau	18 Tzec,	Sept. 5, 274 A.D., 24 days after Inf. Conj.
9- 8- 0- 0- 0,	5 Ahau	3 Chen,	Oct. 28, 333 A.D., 18 days after Inf. Conj.
9-11- 0- 0- 0,	12 Ahau	8 Ceh,	Dec. 15, 392 A.D., 11 days after Inf. Conj.
9-14- 0- 0- 0,	6 Ahau	13 Muan,	Feb. 4, 452 A.D., 5 days after Inf. Conj.
9-17- 0- 0- 0,	13 Ahau	18 Cumhu,	Mar. 27, 511 A.D., At Inferior Conj.
10- 0- 0- 0- 0,	7 Ahau	18 Zip,	May 17, 570 A.D., 2 days before Inf. Conj.
10- 3- 0- 0- 0,	1 Ahau	3 Yaxkin,	July 6, 629 A.D., 5 days before Inf. Conj.

[1] This would be near the brightest phase of Venus as morning star. Whether this phase was ceremonially observed appears doubtful. One early record at Uaxactun namely that of Stela 9 gives a position 20 days after heliacal rising.

It will be observed that 8·16· 0· 0· 0, 3 Ahau 8 Kankin, April 5, 97 A. D. is found in all three lists. It also corresponds to the vernal station of the first arrangement of the astronomical base line at Copan and appears to be reached by a special line of observation at Uaxactun where two monuments record the date, namely Stelae 18 and 19. Stela 5 at this early site records April 12, the highly emphasized date of the Venus calendar in the following relation:

8·16· 0· 0· 0,	3 Ahau	3 Kankin,	Apr. 5, 97 A. D.
1· 0·12			
8 16· 1· 0 12,	11 Eb	15 Kankin,	Apr. 12, 98 A. D.

The next katun ending emphasized in two of the lists is 8·19· 0· 0· 0, 10 Ahau 13 Kayab, May 26, 157 A. D., recorded on Stela 17 at Uaxactun and reached by subtraction on the Hieroglyphic Stairway at Seibal in what is possibly a calculation of Venus import. The Initial Series of Stela 3 at Tikal may have an implied connection since it registers a date 73 tuns later, thereby reaching the same month position and very nearly the same relation to the planet. Katun 2 of Baktun 9 is found on Stela 9 of Tikal but I am not able to discern any Venus hieroglyphs in the inscription. Venus appeared as morning star on the summer solstice about 25 days before this date. 9· 4· 0· 0· 0, 13 Ahau 18 Yax, December 18, 254 is the point of departure for the long series of the Temple of the Inscriptions at Palenque, which touches many of the subsequent dates in these lists.

Most of the round numbers of interest in the Venus cult which are shown in the preceding lists are accompanied by Venus glyphs except in a few cases where a greater interest intervenes. Where the numbers are declared by the Initial Series, or are prominent in inscriptions which begin with Initial Series, the designation is often

FIG. 5. TITLE GLYPHS OF THE SUMMER SOLSTICE.
Left to right: Stela 1, Los Higos; Lintel 1, El Cayo; Stela 11, Yaxchilan.

accomplished by means of the title, a name here applied to the variable element occupying the central position in the introducing glyph above the tun sign and between the comb-like elements.

TITLE GLYPHS

The validity of the title glyph, as a true index of subject matter, may be open to some doubt and I therefore think it proper to give a few cases besides those which involve glyphs in the Venus

series. I first direct attention to three inscriptions which have the same title element in the introducing glyph, namely a device something like a tun, but recognizably different. The first inscription at Los Higos has two dates, the first exactly equalling the summer solstice, namely:

9-17-10- 7- 0,	9 Ahau	3 Tzec,	June 22,	521 A. D.
7- 0	subtract			
9-17-10- 0- 0,	12 Ahau	8 Pax,	Feb. 2,	521 A. D.

The second inscription is Lintel 1 at El Cayo, the first three dates of which are

9-16- 0- 2-16,	6 Cib	9 Mol,	Sept. 3,	491 A. D.
11-17-10				
9-16-12- 2- 6,	13 Cimi	19 Zotz,	June 23,	503 A. D.
2- 4				
9-16-12- 4-10,	5 Oc	3 Yaxkin,	Aug. 6,	503 A. D.

Here the second date is that of the summer solstice, the last gives a true anniversary from the epoch of the Historical era and the first may refer either to the autumnal station in combination with April 9 or to a position in the Venus calendar. The third example is found on Stela 11 at Yaxchilan where the Initial Series date registers 9-16- 1- 0- 0, 11 Ahau 8 Tzec, July 3, 492. This seems far off from the summer solstice but by adding one calendar round the proper location is found, namely:

9-16- 1- 0- 0,	11 Ahau	8 Tzec,	July 3,	492 A. D.
2-12-13- 0				
9-18-13-13- 0,	11 Ahau	8 Tzec,	June 22,	544 A. D.

Now this date in calendar round form is found several times at Yaxchilan. On Stela 12 it occurs in combination with another date, the two giving about the same arrangement as the second and third dates on the El Cayo lintel, namely:

9-18- 3-12-14,	6 Ix	12 Yaxkin,	Aug. 7,	534 A. D.
10- 0- 6				
9-18-13-13- 0,	11 Ahau	8 Tzec,	June 22,	544 A. D.

In another place at Yaxchilan (Lintels 27 and 28) the first of these dates is placed a calendar round earlier and a second distance number added to it also reaches the summer solstice, thus:

9-15-10-17-14,	6 Ix	12 Yaxkin,	Aug. 19,	482 A. D.
6-17- 0				
9-15-17-16-14,	10 Ix	17 Zotz,	June 23,	489 A. D.

On the several monuments at Yaxchilan that deal in these diverse ways with the summer solstice the hieroglyph that forms the title element in the three inscriptions is prominent. It is also prominent at Quirigua in connection with a frequently repeated date that also can be reduced to the summer solstice by adding one calendar round, namely:

9 15· 6·14· 6, 6 Cimi 4 Tzec, July 3, 478 A. D.

I find a perhaps more impressive example of its use on the Temple of the Cross at Palenque. After dealing with a date near the epoch of the Mundane era, which demonstrates the ability of the Maya astronomers to state definite times of the tropical year so far in the past, the record gives:

1·18· 5· 3· 2, 9 Ik 15 Ceh, Dec. 21, 2619 B. C.

which is the winter solstice. But this statement is associated with a summer solstice glyph capped by an S-shaped detail which seems elsewhere to mean reversal. And it happens that 15 Ceh coincided with the summer solstice at the epoch of the Mundane era and the distance number gives a time sufficient for 15 Ceh to move half way around the tropical year in terms of the Maya uncorrected year.

The titles in introducing glyphs are of several kinds but after all the range is not wide and Venus glyphs are perhaps more common than any other forms, especially the type of Venus glyph which pictures the grotesque head of the Venus monster. There are Sun glyphs and Moon glyphs and others that represent interlacing. One

FIG. 6. TITLE GLYPHS OF THE CEREMONIAL FIRE.

At left title of the Tablet of the Sun at Palenque; title of Lintel 2 at Piedras Negras. Center, passage in the Temple of Inscriptions at Palenque. At right, title of Altar P at Quirigua and glyph of Baktun 9, Temple of the Sun at Palenque.

kind deals with a jaguar head or body. Another shows the face of the God of the Number 7 who rules over the Historical era. Still another title is the ceremonial fire.

I close the brief comment on the title glyphs with a few relating to ceremonial fires. Three examples are notable. The introducing glyph on the Tablet of the Sun at Palenque shows a ceremonial fire as headdress of a grotesque face. The Initial Series reaches a date just four days in advance of the winter solstice, namely:

1-18- 5- 3- 6, 13 Cimi 19 Ceh, Dec. 25, 2619 B. C.

On Lintel 2 at Piedras Negras the title of the introducing glyph is clearly meant to portray the bundle of sticks with the smoke curls of newly kindled fire issuing from the top. The Initial Series date reaches the same position in the Maya year and in the tropical year as the one at Palenque but does not arrive at the same day, namely:

9-11- 6- 2- 1, 3 Imix 19 Ceh, Dec. 25, 398 A. D.

If two grand calendarial cycles of 29 calendar rounds each had been used the day 13 Cimi of the Palenque statement would have been returned. As it is the correspondence is 3 civil years over this limit but the results still fall with December 25 of the Gregorian calendar. A third correspondence is found, not in an Initial Series but in a rather complicated calculation of the Temple of Inscriptions at Palenque reaching forward into the future to the date 5 Lamat 1 Mol placed 8 days in advance of the round number 1-0-0-0-0-0, 10 Ahau 13 Yaxkin, December 17, 4512 A. D., where it also reaches December 25 and is combined with the new fire hieroglyph.

But ceremonial fires were built at other times than December 25. They seem to have been built at terminal or beginning dates (Imix-Ahau signs are frequently combined with smoke scrolls and Imix and Ahau are Alpha and Omega, First and Last). Especially such fires were built in connection with the terminal dates of baktuns. One set concerns 9- 0- 0- 0- 0, 8 Ahau 13 Ceh. The separate glyphs of the era of the Chronicles all have smoke curls at the top and the complete fire bundles are shown in connection with the chronological recordings of Baktun 9. Also the new fire ceremony is used with dates that recapitulate the 13 Ceh of this baktun. Especially prominent in this regard is the Initial Series of Altar P at Quirigua which has as title the fire bundle. It reaches, as we have already seen above, the date 9-18- 5- 0- 0, 4 Ahau 13 Ceh, November 16, 535 A. D. which also has significance in connection with Venus. Other fire bundles, not in introducing glyphs but in the running texts are sometimes combined with ceremonial fires for the Venus cult such as 9-14- 0- 0- 0, 6 Ahau 13 Muan, February 4, 452 A. D. and 9-17- 0- 0- 0, 13 Ahau 18 Cumhu, March 27, 511 A. D., when there was an actual coincidence and even with 9-15- 0- 0- 0, 4 Ahau 13 Yax, October 22, 471 A. D. when the connection with Venus was dilated through the month position 13 Yax.

Further Examples of Inscriptions dealing with Venus

An inscription which pretty clearly refers to Venus is that of the Leyden Plate, the title of the introducing glyph being a grotesque head with the combined Venus-Sun symbol for the ear plug. The date is:

8-14- 3- 1-12, 1 Eb 0 Yaxkin, Nov. 17, 60 A. D.

It will be observed that 0 Yaxkin is the day after the Venus month position 19 Xul and that November 17 is the original location of 18 Kayab in the Venus calendar.

Altar S at Copan is a nice example of an inscription referring

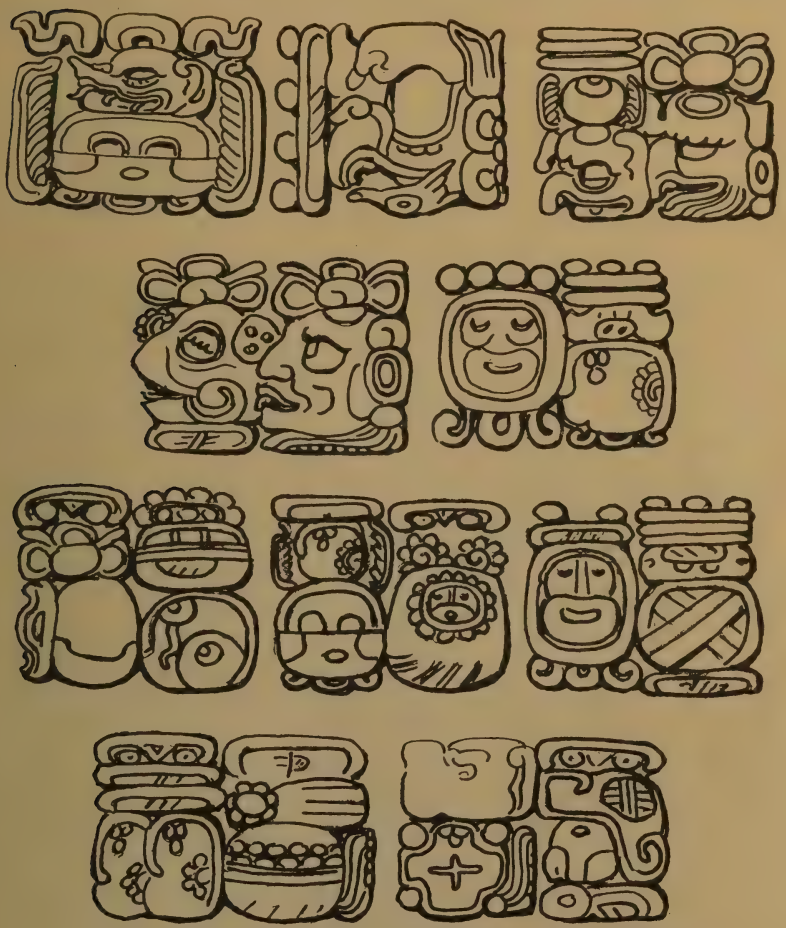

FIG. 7. INSCRIPTION ON ALTAR S AT COPAN.

First two rows give the Initial Series 9-15-0-0-0, 4 Ahau 13 Yax, following an introducing glyph with Venus symbol. Third line, *a*, an unknown ending; *b*, Summer Soltice over Caban (Earth); *c*, 5 katuns; *d*, Imix-Ahau with smoke scrolls; *e* and *f*, 7 Ahau 18 Zip. Fourth row, *a*, Baktun 10; *b*, unknown descriptive; *c*, Venus symbol with superfix; *d*, glyph with some such meaning as "heavenly round."

to Venus. The title is the head of the Venus Monster, and there are two dates declared as follows with the connecting number:

9·15· 0· 0· 0,	4 Ahau 13 Yax,	Oct. 22, 471 A. D.
5· 0· 0· 0		
10· 0· 0· 0· 0,	7 Ahau 18 Zip,	May 17, 570 A. D.

The Imix-Ahau sign with smoke curls precedes the last date and the next to last glyph of the text is a winged Venus symbol of somewhat decorative type.

Altar M at Quirigua has no introducing glyph with title but the monument itself is a grotesque head of the Venus monster, the eye of which is modified into an Imix sign. This gives almost the same complex as Altar S of Copan. The first date is Katun 15 and there are 5 katuns which read an undeclared Baktun 10. Also there is a distance number connecting a date which reaches November 15 of the Venus calendar and 18 Zac of the Historical era, thus:

9 15- 0- 0- 0,	4 Ahau 13 Yax,	Oct. 22, 471 A. D.
3- 2- 0		
9-15- 3- 2- 0,	6 Ahau 18 Zac,	Nov. 15, 474 A. D.
	* * *	
9-15- 0- 0- 0,	4 Ahau 13 Yax,	Oct. 22, 471 A. D.
5- 0- 0- 0		
10- 0- 0- 0- 0,	7 Ahau 18 Zip,	May 17, 570 A. D.

FIG. 8. NEW FIRE AND IMIX-AHAU GLYPHS AT KATUNS 14 and 17.

At left, passage on Stela 23 at Naranjo—Imix-Ahau and Ceremonial Fire in combination with 6 Ahau 13 Muan, end of Katun 14. Center, Stela 1 at Yaxchilan —6 Ahau (13 Muan) New fire. Right, inscription on Altar Z at Copan reading as follows: distance number 1-8-1; Imix-Ahau with smoke scrolls; 13 Ahau 18 Cumhu; glyph with smoke element. Top, glyphs on Temple 22a and the Reviewing Stand at Copan, Imix-Ahau with smoke curls found in combination wth 9-17-0-0-0, 13 Ahau 18 Cumhu.

Altar Z of Copan, already briefly referred to, belongs in the same category as the two just described. It is a rectangular plinth with a grotesque snouted face on the front side—undoubtedly intended for that of the Venus Monster. There is a conspicuous

Imix symbol over the nose and in the headband the dotted smoke curls are prominent. The inscription consists of 12 glyphs covering the remaining three sides of the monument, the top and bottom being plain surfaces. The inscription begins with a distance number 1- 8- 1 followed by the Imix-Ahau smoke symbol combined with a completion sign. After this comes the single date 9-17- 0- 0- 0, 13 Ahau 18 Cumhu, March 27, 511 A. D., which fell in the dark period of the Venus revolution near inferior conjunction. The distance number is evidently intended to be counted both ways as follows:

9-16-18- 9-19,	12 Cauac	2 Zac,	Oct. 22, 509 A. D.
1- 8- 1			
9-17- 0- 0- 0,	13 Ahau	18 Cumhu,	Mar. 27, 511 A. D.
1- 8- 1			
9-17- 1- 8- 1,	1 Imix	9 Mol,	Aug. 29, 512 A. D.

This bifurcated calculation restores the positions in the natural year of two round numbers, namely:

9-15- 0- 0- 0,	4 Ahau	13 Yax,	Oct. 22, 471 A. D.
10- 0- 0			
9-15-10- 0- 0,	3 Ahau	3 Mol,	Aug. 30, 481 A. D.

The second date August 30 pairs with the Venus date April 12 along the line of sight at Copan. In glyph 8 of this inscription there is a Kin-Caan-Caban ideograph of the Sun at the horizon and in glyph 9 we see a Venus symbol combined with a Cauac or rain symbol meaning "relation of Venus to the natural year of the rains."

Venus signs of the normal type (i. e., those agreeing with the commonly recognized forms of the Dresden Codex) are found as title element in the introducing glyph on the following monuments:

Lintel 29, Yaxchilan (See above for explanation).

9-13-17-12-10,	8 Oc	13 Yax,	Oct. 27, 449 A. D.
1- 1-17	subtract		
9-13-16-10-13,	1 Ben	1 Chen,	Sept. 25, 448 A. D.
Altar K, Copan			
9-12-16- 7- 8,	3 Lamat	16 Yax,	Nov. 5, 428 A. D.
Stela 24, Naranjo			
9-12-10- 5-12,	4 Eb	10 Yax,	Oct. 31, 422 A. D.
5- 7-15			
9-12-15-13- 7,	9 Manik	0 Kayab,	Mar. 8, 428 A. D.
11- 8- 1			
9-13- 7- 3- 8,	9 Lamat	1 Zotz,	June 20, 439 A. D.
2-14-12			
9-13-10- 0- 0,	7 Ahau	3 Cumhu,	Mar. 28, 442 A. D.
Stela K, Quirigua			
9-18-15- 0- 0,	3 Ahau	3 Yax,	Sept. 24, 545 A. D.
10-10	subtract		
9-18-14- 7-10,	1 Oc	18 Kayab,	Feb. 26, 545 A. D.
Stela 1, Saccana			
10- 2- 5- 0- 0,	9 Ahau	18 Yax,	Sept. 23, 613 A. D.

Not one of these five inscriptions registers an actual coincidence of Venus in a significent phase nor are the intervals between the

dates Venus intervals. But it will be noted that the Initial Series date in every instance falls in the month Yax. At the inauguration of the Venus calendar an heliacal rising took place on 12 or 13 Yax and we have found the recurrence of this position in the round number 9·15· 0· 0· 0, 4 Ahau 13 Yax, symbolized by Venus glyphs. The first inscription given above has already been explained in combination with the dates on associated lintels in the same structure.

The association on Stela K at Quirigua is a Yax date practically on the autumnal equinox associated with an 18 Kayab date, this latter having affiliations with the Venus calendar. I suspect that the two dates on this monument have a concealed significance as regard some other planet.[1] The interval 10·10 has been explained as the number needed for intercalation of leap year days but this explanation is open to objections.

At any rate the Venus glyph of Stela 1, Saccana forms an interesting commentary. This date is 3·10· 0· 0 in advance of that on Stela K and exactly reaches the autumnal equinox. Indeed, Blom found at Comitan a monument on which this date carries the equinoctial glyph. Now the interval of approximations in the Venus calendar is not 70 tuns but 60 tuns. The case is carried a step farther by the association on Lintel 29 at Yaxchilan when an interlocked date falls on September 25. In the example from Naranjo one association is with a date which nearly coincides with the summer solstice. The day reached in two of our cases is Lamat, which has some special association with Venus. If some of these cases where the Venus hieroglyphs are quite clear seem unusually recondite it must be admitted that the lack of a true Venus interval between the dates presents an equal difficulty in any other system of correlation.

I reserve for later consideration several inscriptions in which the Venus calculations are interlocked with those of the moon. These will probably provide the type explanation that must be followed in several cases like the above. It appears that Maya astronomy was over-laid with astrological considerations and that the priests of those days sought the machinations of fate in the relative positions of planets. We will now proceed with the calendar of the Moon.

The Lunar Calendar

The apparent revolution of the Moon around the Earth, marked by the recurring phenomenon of the new moon, was used by the Mayas as the basis of a lunar calendar. This was distinct from the civil calendar and may have been used for ceremonial purposes. The Mayas probably had a series of movable feasts which depended, like our Easter, on the phases of the Moon.

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[1] 9-18-15- 0- 0, 3 Ahau 3 Yax, September 24, 545 A. D. is a new moon date.

Now the average duration of a lunar revolution is 29 days, 12 hours, 44 minutes, 2.8 seconds. Twelve lunations fall nearly 11 days short of a true year and primitive people whose principal interest is to keep the Moon in adjustment with the seasons have an occasional thirteenth month in their lunisolar calendars. In a second stage we sometimes find twelve conventional months of 30 days each. It has already been explained that an early month of the Mayas was reduced from 30 to 20 days but it must not be imagined that the Mayas lost their interest in the Moon from this convention. Indeed they rapidly developed ways of dealing with the Moon which command the highest respect of astronomers.

Among other things they discovered independently the correspondence between 6940 days, 19 tropical years and 235 lunations with which the name of the Greek astronomer Meton is commonly associated. They were able to use this natural cycle with much greater facility than the Greeks by reason of a remarkable coincidence: in Maya notation 1 katun minus 1 tzolkin gives exactly 6940 days. The subtraction can be written as follows:

1· 0· 0· 0	= 7200	days
13· 0	= 260	"
19· 5· 0	= 6940	"

The interval of the Metonic Cycle is used prominently in several lunar calculations at Copan.

A much more accurate and remarkable lunar cycle of the Mayas is developed on pages 51 to 58 of the Dresden Codex. Here a succession of 405 lunations, amounting to nearly 33 years, is calculated in groups of five and six lunations, the former given as 148 days and the latter as 177 or 178 days. These are eclipse intervals and the purpose was evidently to form a table from which eclipses of either the Sun or Moon could be foretold. The count covers a total of 11,960 days[1] and contains the tzolkin just 46 times. It therefore makes a reentering cycle as regards day names, and is capable of being used over and over again. By modern calculation 405 apparent lunar revolutions are only 0.112 of a day less than 11,960 days, therefore this Maya pattern of the Moon's motion will run for nearly 300 years before the accumulating error amounts to a day. Since the table is arranged to depart from three receding days, namely 12 Lamat, 11 Manik, and 10 Cimi, it has been assumed that the first of these could be used for 8 cycles, after which the calendar would slip down to the second day and be set for a second series of 8 cycles etc. The historical positions at which the elaborate calendar of the Dresden Codex was intended to apply have not been determined. The difficulty lies in finding an arrangement of solar eclipses that will fit the eclipse indications. Professor Willson devoted much labor to this eclipse data but without effecting a

[1] This is divided into approximate thirds (3986 and 3987 days) an interval after which eclipses return called by Willson the Maya Saroid.

chronological correlation capable of meeting all demands. It is highly probable, I think, that the Lunar calendar of the Dresden Codex will be found to have an adjustment to conditions at the beginning of the Thirteenth century in keeping with the adjustment with actual appearances of Venus found for Calendar B of the Venus table in the same manuscript.

The Supplementary Series

Following the Initial Series declaration on many monuments of the First Empire is a Supplementary Series which clearly involves a lunar count. The last glyph, called Glyph A in Morley's nomenclature, is a moon having the numerical value 20 combined with a coefficient 9 or 10 to make a 29 or 30 day month. Other glyphs, mostly lettered in reverse order, have numerical values as demonstrated by Teeple. These belong in short counts which do not exceed 6 or possibly 7 lunations,[1] and which are assumed to fit into a pattern of eclipse probabilities similar to the one which finds expression in the Dresden Codex. Glyph C records complete lunations which may not exceed six. Glyph D states the number of days in an incomplete lunation which may not exceed 19. Glyph E without coefficient has the value of twenty days in an incomplete lunation and its coefficients record the days above twenty.

These lunations are not counted from a uniform series of bases nor do they reach true places of the moon in the correlation used in this paper. It has therefore been argued that the correlation was in error and an effort has been made to find another by the method of departing from a point where some one series coincided with a true phase of the Moon. Such a method, however, brings its own difficulties. In the first place it is not certain whether the days of the Moon are counted from new moon or full moon. In the second place the arbitrary selection brings no series of recorded eclipses into display. In the third place a correlation chosen to satisfy certain assumed conditions as regards the Moon fails to meet the historical evidence of double datings, both of the Sixteenth century and of ancient times.

But there is the unconsidered possibility that the lunar calendar of the Mayas resembles their other calendars in being of the uncorrected type so that the true positions of the Moon depart from the calendarial positions by the amounts of an accumulating error. In the present study the records of the Supplementary Series are explained as having an error of this type.

Examining Supplementary Series found on monuments of the First Empire which record by Initial Series the same date, it is disclosed that they are frequently counted from different bases, i. e., the coefficients of Glyph C, which give complete lunations, differ.

[1] When Glyph C has the value six it is reduced by Teeple's system to zero.

		Glyph C	Glyph D	Glyph E	Total Days of Base before Date
Naranjo	Stela 24	1	18	0	48
"	" 29	6	19	0	19 (or 19+177=196)
		*	*	*	
Piedras Negras	Stela 1	3	0	8	117
" "	" 3	2	0	7	86
		*	*	*	
Quirigua	Stela J	6	4	0	4 (or 4 + 178=182)
Copan	" M	5	5	0	153
		*	*	*	
Quirigua	Stela E	2	0	0	59
Honradez	" 7	3	0	0	89

It will be observed that the maximum variation is one lunation, particularly if 6 C is counted as 0 C.

Now let us examine the record of the last two monuments in still another light. In Oppolzer's Canon of Solar Eclipses[1] a total eclipse with its line of centrality across Yucatan and Venezuela occurred in the year 511 A. D. on Julian Day 1,907,715 which reduces to the Maya date 9-16-19-14-11, 9 Chuen 9 Muan, Jan. 17, 511 A. D. Since the initial series of Stela 7 at Honradez and Stela E at Quirigua record 9-17- 0- 0- 0, 13 Ahau 18 Cumhu, March 27, 511, the difference between the time of this eclipse (necessarily at the new moon) and the ending day of the recorded Katun is 69 days. In other words Maya number 9-17- 0- 0- 0 in the Long Count really corresponds to 10 days after new moon or 4 days before full moon, whereas the statement of the Supplementary Series reaches the even lunation.

The assumption has been made, I believe, that the lunations of the Supplementary Series were counted from the new moon, if so probably the observed new moon rather than the moment of the invisible conjunction of the Moon with the Sun. But the lunations may have been counted from full moon. If the difference between the calendarial moon and the true places—10 days over the new moon or 4 days less than the full moon—are to be explained by the accumulated error of an uncorrected lunar calendar then the least error would be found in connection with a calendar giving results slightly longer than a sum of true revolutions. Now the Lunar calendar of the Dresden Codex based on the 11,960 day cycle, is the one concerning which we have the most explicit evidence and this is, in fact, enough longer than the true places to account for one day error in something like 300 years. Therefore it is possible that the lunar places were calculated in the Supplementary Series in accordance with this slightly erroneous Lunar calendar. If this theory is correct we should have complete parallelism with conditions in the civil and Venus calendar which are inviolate patterns. It is also possible that the Metonic cycle was used to form a kind of

[1]T. R. von Oppolzer: *Canon der Finsternisse* Denkschriften der Kaiserl. Akad der Wissensch. Math-Naturw. Classe, Vol. CCV. Wien, 1887.

lunar calendar in which case the error would be much greater and the displacement also greater.

Proof that numbers in the Supplementary Series were reached on the 11,960 basis, by means of a calendarial pattern rather than by concurrent observation, may be deduced from the fact that the three major Initial Series at Palenque recording dates thousands of years before the beginning of history are correct in Teeple's tables. Here we must imagine that lunar statements were projected backwards from an historical base corresponding to about 430 A. D. These three series are:

Temple of Cross—		
12-19-13- 4- 0,	8 Ahau 18 Tzec,	Feb. 7, 3379 B. C.
Temple of Sun—		
1-18- 5- 4- 0,	1 Ahau 13 Mac,	Dec. 25, 2619 B. C.
Temple of Foliated Cross—		
1-18- 5- 3- 6,	13 Cimi 19 Ceh,	Jan. 8, 2618 B. C.

Interrelations in Tables of Venus and the Moon

The Lunar calendar of the Dresden Codex is a reentering series covering 405 lunations, 46 tzolkin, and 11,960 days, concerned primarily with intervals after which eclipses can recur. This table has in its preamble several dates in the Long Count which are found to be significant in Venus calculations. Conversely the preamble of the Venus calendar has dates of interest in calculations concerning the Moon.

We have already seen that the original calendar of Venus departed from the month position 18 Kayab (and from four other positions at intervals of 584 days). In the codex the particular day 1 Ahau 18 Kayab is designated for Calendar A. Calendar B is given a position in the preamble long before the true historical position where it actually coincides with the significant appearances of Venus. The date 1 Ahau 13 Mac can be placed exactly one cycle of the Lunar calendar away from the hypothetical position of 1 Ahau 18 Kayab, namely:

9- 9- 9-16- 0,	1 Ahau 18 Kayab,	Apr. 12, 363 A. D.
1-13- 4- 0	11960 days	
9-11- 3- 2- 0,	1 Ahau 13 Mac,	Jan. 9, 396 A. D.

The first date is declared by distance number on page 24 of the Dresden Codex, this page being in the nature of an introduction to the Venus calendar. While 1 Ahau 13 Mac is not stated to fall in the arrangement given above, we do find the date in the Initial Series of the tablet of the Foliated Cross at Palenque, occupying the same position of the natural year but just 58 calendar rounds distant in the past. Since 58 calendar rounds are twice the Maya cycle of concordance ($29 \times 52 \times 365 = 1508$ calendar years $= 1507$ tropical years) the same Maya and Gregorian statements are brought

together. Also it is interesting to note that this restores positions of the Moon within .64 of a day.[1]

It may be pure accident that the first distance number in Column D of page 24, which amounts to 416 calendar years or 260 Venus revolutions, gives recapitulation of January 9 when added to the stated position of 1 Ahau 18 Kayab, thus:

9· 9· 9·16· 0,	1 Ahau 18 Kayab,	Apr. 12, 363 A. D.
1· 1· 1·14· 0		
10·10·11·12· 0,	1 Ahau 18 Kayab,	Jan. 9, 778 A. D.

I believe this harping on January 8 or 9 (according to the inequalities of the Gregorian equivalents) reveals the important position used in calculations dealing with the Moon during the First Empire.

There are two other positions of 1 Ahau 13 Mac which follow from the numbers in connection with the Venus table. The second distance number in Column E of page 24 is a proper interval, thus:

9· 9· 9·16· 0,	1 Ahau 18 Kayab,	Apr. 12, 363 A. D.
9·11· 7· 0		
9·19· 1· 5· 0,	1 Ahau 13 Mac,	Dec. 2, 551 A. D.

Lastly Calendar B of the Venus table finds 1 Ahau 13 Mac at the summer solstice and likewise in touch with actual heliacal risings of Venus as morning star.

We now proceed to the Lunar table, more especially to the introductory material in the upper half of pages 51 and 52. Here are six interlocking red and black numbers counted from the Mundane era, one pair being on the left and two pairs on the right. Between them is a section of 11 shorter numbers which are primarily multiples of 11,960 although three may be errors or intentional variations from exact multiples. Several emendations in the numerals of the six long numbers are necessary but these have long since been agreed upon by Förstemann, Bowditch and other students and need not be explained at this time.

The first column reads down as follows: 4 Ahau, 8 Cumhu, 12 Lamat, 8 days, knotted Imix. Then come the numbers 8·16· 4· 8· 0 and 10·19· 6· 1· 8 with 12 Lamat repeated at the bottom of the column. These numbers count from the Mundane Era, 13· 0· 0· 0· 0, 4 Ahau 8 Cumhu, October 14, 3373 B. C. In one case 4 Ahau 3 Zip is reached and when the 8 days are added we get 12 Lamat 11 Zip. In the other case 12 Lamat 6 Cumhu is reached and when the 8 days are subtracted 4 Ahau 18 Kayab is obtained. The transformation into Gregorian dates, with the age of the Moon[2] appended in the last column yields:

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[1] 550420 days = 19638 lunations less .64 of a day.

[2] I have used Oppolzer's Canon of Eclipses to give new moon positions within 6 lunations, reducing these to the meridian of Copan. Order in error of the Moon may interfere but the accuracy is sufficient for the present purpose. The age index gives the phase of the Moon at the beginning of the day in question.

A	13- 0- 0- 0- 0,	4 Ahau	8 Cumhu,	Oct. 14,	3373 B. C.	
	8-16- 4- 8- 0	add				
B	8-16- 4- 8- 0,	4 Ahau	3 Zip,	Aug. 23,	101 A. D.	11.7
	8	add				
C	8-16- 4- 8- 8,	12 Lamat	11 Zip,	Aug. 31,	101 A. D.	19.7
		* * *				
A	13- 0- 0- 0- 0,	4 Ahau	8 Cumhu,	Oct. 14,	3373 B. C.	
	10-19- 6- 1- 8	add				
D	10-19- 6- 1- 8,	12 Lamat	6 Cumhu,	Nov. 24,	950 A. D.	10.4
		subtract				
E	10-19- 6- 1- 0,	4 Ahau	18 Kayab,	Nov. 20,	950 A. D.	2.4

Here the month position 3 Zip of Date B belongs in the Venus series of emphatic positions in the Maya year and 8 days is the interval of obscuration of Venus at inferior conjunction while the day Lamat, reached by the addition, is again closely connected with this planet. August 31, to be thought of as August 30 since the year 101 comes at a time of uneven correction in the Gregorian calendar, is a position in the natural year reached by the final adjustment of the astronomical base line at Copan. Its reciprocal date of sunset reading along the adjusted base line is April 12, the prime position of Venus in the natural year which is treated in the Venus table of the Dresden Codex, as well as on several important monuments. Date D records Lamat, the sacred day of Venus, and Date E reaches an actual heliacal rising of this planet on its special month position 18 Kayab. It is this date which gives us the historical location of Calendar A of the Venus table already sufficiently discussed.

The difference between the two long numbers actually written out in this passage, namely, 8-16- 4- 8- 0 and 10-19- 6- 1- 8, is 310,188 days or about a day less than 10,504 lunations. The Moon in the first case is 11.7 days old and in the second case is 10.4 days old, averaging about 4 days before the full phase. But with the coefficient of error observed in the count of the Supplementary Series these may correspond to even lunations.

The multiplication table is concerned with parts and multiples of 11,960 and is tied in with five different days, namely 12 Lamat, 1 Akbal, 3 Eznab, 5 Ben and 7 Lamat which lie in the tzolkin exactly 15 days apart in the order given. Four numbers, recorded in two columns, lead to four of these days and Förstemann suggested in his Commentary on the Dresden Codex that a fifth number had been suppressed for lack of space, namely the one leading to 5 Ben. This can be placed 15 days before 7 Lamat 1 Muan. Omitting the unnecessary repetitions of Date A, the Epoch of the Mundane era, we then have:

F	9-16- 4-10- 8,	12 Lamat	1 Muan,	Jan. 11,	496 A. D.	10.
	15					
G	9-16- 4-11- 3,	1 Akbal	16 Muan,	Jan. 26,	496 A. D.	25.
	15					

H	9-16- 4-11-18,	3 Eznab	11 Pax,	Feb. 11,	496 A. D.	10.5
		* * *				
F	9-16- 4-10- 8,	12 Lamat	1 Muan,	Jan. 11,	496 A. D.	10.
	3- 0-15- 0					
I	9-19- 5- 7- 8,	7 Lamat	1 Muan,	Dec. 28,	555 A. D.	27.8
	15	subtract				
J	9-19- 5- 6-13,	5 Ben	6 Kankin,	Dec. 13,	555 A. D.	12.8

The dates reaching 10 and 25 days of the Moon are full and new moon dates in the system of the Supplementary Series, but this circumstance alone offers little comfort.

Lunar Coincidences Recorded on Monuments

At Copan an extraordinary number of monuments declare Katun 11 and some of these have the face of the Moon Goddess as title in the introducing glyph. It appears that this date nearly coincided with a full moon and that the still more important round number which is the base of the era of the Chronicles, namely 9- 0- 0- 0- 0, 8 Ahau 13 Ceh, was also a full moon date. These two dates are recorded in conjunction on Stela 3 at Copan in connection with interesting hieroglyphs of the moon.

But there is another date lying just one hotun before Katun 11, that seems somewhat more sharply adjusted to full moon. This is 9-10-15- 0- 0, 6 Ahau 13 Mac, January 11, 388 A. D. Moreover it lies exactly 8 calendar years distant from 1 Ahau 13 Mac in significant connection with 1 Ahau 18 Kayab. The following relation of dates contains, I believe, the key to ancient lunar calculations which find echo in the Dresden Codex.

9-10-15- 0- 0,	6 Ahau 13 Mac,	Jan. 11,	388 A. D.	
8- 2- 0	add			
9-11- 3- 2- 0,	1 Ahau 13 Mac,	Jan. 9,	396 A. D.	
1-13- 4- 0	subtract			
9- 9- 9-16- 0,	1 Ahau 18 Kayab,	Apr. 12,	363 A. D.	

The first date is an actual full moon date and the second and third ones are hypothetical full moon dates in the distorted Lunar calendar of the Supplementary Series.

Before going farther let us examine some of the correspondences between lunations and calendar years and between lunations and round numbers in the day count that we may have means of intelligent comparison of lunar intervals in the Maya pattern. The lowest close adjustments between lunations and calendar years are the following.

A { 3 × 365 days = 1095 days
  { 37 lunations = 1092.63 "

B { 8 × 365 days = 2920 days
  { 99 lunations = 2923.53 "

C { 11 × 365 days = 4015 days
  { 136 lunations = 4016.16 "

D { 14 × 365 days = 5110 days
  { 173 lunations = 5108.79 "

E { 25 × 365 days = 9125 days
  { 309 lunations = 9124.95 "

The last is remarkably close and covers a convenient period: other adjustments can be reached by using multiples and combinations of the above.

Next we have the outstanding correspondences between lunations and round numbers in the Maya day count.

		Days in Period	Mean Error
A	5 tuns (one hotun)	= 1800. days	
	61 lunations	= 1801.37 "	+ 1.37
B	1 katun	= 7200. "	
	244 lunations	= 7205.46 "	+ 5.46
C	5 katuns and 10 tuns	= 39600. "	
	1341 lunations	= 39600.52 "	+ .52
D	10 katuns and 15 tuns	= 77400. "	
	2621 lunations	= 77399.67 "	— .33

Applying these intervals to the sequence of round number dates in the Long Count we get pretty close correlations with full and new moons at the following points during the First Empire:

APPROXIMATE FULL MOONS

9- 0- 0- 0- 0,	8 Ahau 13 Ceh,	Feb. 10, 176 A. D.	13.75
9- 5-10- 0- 0,	10 Ahau 8 Zip,	July 14, 284 A. D.	13.9
9-10-15- 0- 0,	6 Ahau 13 Mac,	Jan. 11, 388 A. D.	14.2
9-11- 0- 0- 0,	12 Ahau 8 Ceh,	Dec. 15, 392 A. D.	13.5
9-16- 5- 0- 0,	8 Ahau 8 Zotz,	June 12, 496 A. D.	13.6
10- 1-10- 0- 0,	6 Ahau 8 Pop,	Mar. 24, 580 A. D.	14.4

APPROXIMATE NEW MOONS

9- 2-10- 0- 0,	3 Ahau 8 Cumhu,	May 25, 225 A. D.	.75
9- 8- 0- 0- 0,	5 Ahau 3 Chen,	Oct. 26, 333 A. D.	.3
9-13-10- 0- 0,	7 Ahau 3 Cumhu,	Mar. 28, 442 A. D.	.9
9-18-15- 0- 0,	3 Ahau 3 Yax,	Sept. 24, 545 A. D.	.1
9-19- 0- 0- 0,	9 Ahau 18 Mol,	Aug. 29, 550 A. D.	1.4

The full moon dates, 9-10-15- 0- 0, 6 Ahau 13 Mac, January 11, 388 A. D. and 9-11- 0- 0- 0, 12 Ahau 8 Ceh, December 15, 392 A. D., are abundantly recorded at Copan. The first has been read on two important monuments, namely Stela 12, the eastern marker of the astronomical base line, and Stela 2, and the second on no less than six major monuments, namely Stelae 12, 2, 19, 23, 13 and 3. It is also possible that this katun ending is recorded on Stela 10, the western marker, and on the West Altar of Stela 5.

Stela 3, the most elaborate of the stelae named above, has two initial series and a statement of 13 uinals, perhaps intended to be subtracted from the "contemporary" date, as follows:

9- 0- 0- 0- 0,	8 Ahau 13 Ceh,	Feb. 10, 176 A. D.	13.7
	* * *		
9-11- 0- 0- 0,	12 Ahau 8 Ceh,	Dec. 15, 392 A. D.	13.5
13- 0			
9-10-19- 5- 0,	12 Ahau 13 Kayab,	Mar. 30, 392 A. D.	19.3

This last date brings up the interesting problem of the Metonic cycle. The permutation of the tzolkin, so important in the Maya calendar, consists of 260 days while 9 lunations amount to 265.77 days. But the difference of 5.77 days, while considerable, is applicable (with a slight correction) to an entire katun because one katun minus one tzolkin equals 6940 days which is the Metonic cycle expressing the close correspondence between 235 lunations and 19 tropical years. Therefore when the Maya astronomer priest subtracted a tzolkin from Katun 11 he recovered the phase of the Moon and the place in the tropical year of Katun 10. Thus:

9-10- 0- 0- 0,	1 Ahau 8 Kayab,	Mar. 30, 373 A. D.	18.9
19- 5- 0			
9-10-19- 5- 0,	12 Ahau 13 Kayab,	Mar. 30, 392 A. D.	19.3
13- 0			
9-11- 0- 0- 0,	12 Ahau 8 Ceh,	Dec. 15, 392 A. D.	13.5

That this is not an accidental correspondence is disclosed by the fact that Stela I finds the same interval from Katun 11 and recovers thereby the original month position of Baktun 9 as well as approximately the same phase of the Moon. Here the statement in the Maya calendar is:

9- 0- 0- 0- 0,	8 Ahau 13 Ceh,	Feb. 10, 176 A. D.	Full Moon
11- 0- 0- 0			
9-11- 0- 0- 0,	12 Ahau 8 Ceh,	Dec. 15, 392 A. D.	Full Moon
19- 5- 0			
9-11-19- 5- 0,	10 Ahau 13 Ceh,	Dec. 16, 411 A. D.	Full Moon

This is the same as saying that 2856 lunations equals 236 calendar years. By multiplication we find that the former amounts to 84,339.37 days and the latter to 84,340 days, leaving a discrepancy of .63 of a day.

The interval of the Metonic cycle appears more prominently still in calculations on Stelae A and C and Altar U at Copan, which involve Venus and the resettings of the astronomical base line, as well as on Stela F at Quirigua which relates to about the same subject. Considerations of these inscriptions will be taken up shortly.

The Maya civil calendar appears to have been inaugurated about 580 B. C. when 0 Pop coincided with the winter solstice, and we may be permitted to look for a lunar base at about the same time. As it happens the second katun after the beginning of their day count was a round number which nearly coincided with full

moon, namely 7- 2- 0- 0- 0, 6 Ahau 18 Pop, January 9, 573 B. C.[1] It will be noted that such a base might account for the repetition of lunar dates on January 9.

A point that has been stated before deserves re-emphasis. This is the fact that inscriptions containing dates which reach new and full moons have Supplementary Series that follow the dislocated calendar while indicating the actual coincidence with moon glyphs combined with ending signs which fall outside the Supplementary Series. Space does not permit comparisons of texts.

Two Interlocking Calculations of Venus and the Moon

I will now direct attention to a number of inscriptions in which calculations of Venus and the Moon, not to mention natural and ceremonial stations in the tropical year are intimately interlocked. The important series of dates on Altar U will make an excellent beginning. When I made my earlier explanation of the dates on this monument I was unaware of the full significance of some of them. It seemed strange that the dates should be stretched over so many years to accomplish the demonstration of the base line shifts. This dilation is now explained by the effort to find propitious days of Venus and the Moon.

Altar U, Copan

Morley's readings are followed: since these were not made with present arguments in view no criticism of forcing the issue on some points will hold.

A	9-14-19- 5- 0,	4 Ahau	18 Muan,	Feb. 4, 471 A. D. Moon 26.8 days old
	13- 0			
B	9-15- 0- 0- 0,	4 Ahau	13 Yax,	Oct. 22, 471 A. D. Moon 21.5 days old
	* * *			
C	9-15- 8-10-12,	2 Eb	0 Pop,	Apr. 9, 480 A. D. Moon 11.8 days old
	* * *			
D	9-15- 9- 0- 2,	9 Ik	10 Mol,	Sept. 6, 480 A. D. Full moon (14.7)
	* * *			
E	9-15- 9-10-17,	3 Caban	0 Pop,	Apr. 9, 481 A. D. Moon 23 days old
	2-13- 0			
F	9-15-12- 5-17,	8 Caban	10 Mac,	Dec. 15, 483 A. D. Moon 1.5 days old
	* * *			
G	9-15-12- 5- 0,	4 Ahau	13 Ceh,	Nov. 28, 482 A. D. Full moon (14 days)
	* * *			
H	9-15-12- 5- 7,	11 Manik	0 Mac,	Dec. 5, 483 A. D. Moon 21.5 days old
	1- 0- 0-10			
I	9-16-12- 5-17,	6 Caban	10 Mol,	Sept. 2, 503 A. D. Moon 23.1 days old

[1] The full moon coincidence comes the day before on January 8.

Date A is one Metonic cycle distant from 9·14· 0· 0· 0, 6 Ahau 13 Muan, February 4, 452 A. D., when an heliacal rising of Venus took place in conjunction with the Moon: see also the calculations on Stelae C and A for this date.

Dates B and H. Same phase of the Moon reached in both. First date important in Venus calendar.

Date D. Here we have 10 Mol (compare 6 Caban 10 Mol) September 6 (compare April 5, its reciprocal on the first base line arrangement and the inferior conjunction of Venus reached by the initial series date of Stela A) and a full moon. One original marker of the base line (Stela 10) has 9·10·19·13· 0, 3 Ahau 8 Yaxkin, September 6, 392 A. D. just after new moon[1] (1.4) and the other marker (Stela 12) has 2 approximate full moon dates at 9·10·15· 0· 0, 6 Ahau 13 Mac, January 11, 388 and 9·11· 0· 0· 0, 12 Ahau 8 Ceh, December 15, 392.

Dates E and I. A Maya new year's day with the Moon 23 days old is tied in with the reciprocal base line date with the moon 23.1 days old.

Date F. Here we have 10 Mac, comparable to the 13 Mac of 9·10·15· 0· 0, January 11, 388 A. D. on December 15, the position in the natural year of 9·11· 0· 0· 0, 12 Ahau 8 Ceh, December 15, 392 A. D. The Moon's phase is that of the September 6 date of Stela 10.

Date G. 13 Ceh, a full moon date comparable to the full moon date on 13 Ceh at 9· 0· 0· 0· 0, 8 Ahau 13 Ceh, February 10, 176 A. D. Also compare 8 Ceh, the full moon date at Katun 11 and 9·11·19· 5· 0, 10 Ahau 13 Ceh, December 16, 411 A. D., a full moon date recorded on Stela I.

Date I. The date of the astronomical congress at Copan, recorded more frequently than any other date at this city. The reciprocal date of April 9 reached in C and D. The Moon the same phase as Date D.

Stela C, Copan

This stela refers to interlocking counts of the Moon and of Venus, as the Moon and Venus titles in the two introducing glyphs plainly indicate. The dates are:

A	9·14· 0· 0· 0,	6 Ahau 13 Muan,	Feb. 4, 452 A. D. Moon 26.4 days old
	11·14· 5· 1· 0	subtract	
B	10·19·14·17· 0,	6 Ahau 18 Kayab,	Apr. 12, 4165 B. C. Moon 24.5 days old

* * *

[1]This may be the observed new moon, that is the first visibility after conjunction.

C	9-14-19- 5- 0,	4 Ahau	18 Muan,	Feb. 4,	471 A. D. Moon 26.8 days old
		* * *			
D	9-14- 6- 7- 0,	5 Ahau	18 Uo,	May 23,	458 A. D. Moon 23.3 days old
E	9-14- 9- 5- 0,	5 Ahau	8 Cumhu,	Mar. 28,	461 A. D. New moon
F	9-14-18-10- 0,	4 Ahau	18 Uo,	May 20,	470 A. D. Moon 2.4 days old

These dates will now be taken up seriatim.

Date A. An actual heliacal rising of Venus which coincides with the end of a katun. It was the closest of a remarkable series of such coincidences, at intervals of 3 katuns, which took place at the height of the First Empire. The Moon on this day was a disappearing crescent (aged 26.4 days) rising before sunrise in fairly close conjunction with the morning star.

Date B. The long distance number amounts in years to 4165 + 452 or 4617 years less 68 days. This number of years is 19 times the 243 year cycle of Venus and the tropical year, and 243 times the Metonic cycle of the moon and tropical year. Both of these cycles are slightly over the times of the phenomena and in the term covered Venus would recede about 38 days and the moon about 75.7 days. April 12 and 18 Kayab are both original calendarial positions of Venus, one in the tropical year and the other in the Maya year. But lunations are such short periods that correspondences within them carry no factor of safety especially over such a long period. As regards Venus other circumstances must be taken into consideration. Within the limits of dates on Stelae C and A there took place heliacal risings of Venus as morning star in positions which are distinctly of interest in connection with the record before us.

9-14- 3- 4- 5, 8- 2- 0	1 Chicchan	3 Uayeb,	Apr. 14, 453 A. D.
9-14-11- 6- 5, 8- 2- 0	9 Chicchan	3 Uayeb,	Apr. 12, 463 A. D.
9-14-19- 8- 5,	4 Chicchan	3 Uayeb	Apr. 10, 471 A. D.

Perhaps by close calculation the last of these can be reduced to 3 Kan 2 Uayeb, April 9. It will be observed at once that while the dates for the actual positions of Venus agree with an original calendarial position in the natural year (that of 19 Xul on April 12) the dates in the Maya year fall some 25 days after 18 Kayab. In the Venus table of the Dresden Codex we find 1 Ahau 18 Kayab on April 12, far from any current appearance of Venus, exactly one century from the middle date:

9- 9- 9-16- 0, 5- 1- 8- 5	1 Ahau	18 Kayab,	Apr. 12, 363 A. D., Venus table, Dresden Codex	
9-14-11- 6- 5,	9 Chicchan	3 Uayeb,	Apr. 12, 463 A. D., Heliacal rising of Venus	

We leave for the present the consideration of this date in the distant past and its current analogies.

Date C. This date was read by Morley on a much effaced portion of Stela C. It also occurs on Stela A and appears to be the hidden starting point of Altar U. The interval is that of the Metonic cycle from Katun 14 and the same phase of the Moon is recovered within 0.3 of a day.

Date D. In connection with Date D we will consider E, F, C and several other numbers, the intervals between which have interesting sets of common factors. Date C is also concerned and there is still another date, 9·15· 1· 8· 0, 4 Ahau 8 Cumhu, March 25, 473, probably recorded on Stela A, and almost certainly to be understood here. The Arabic numbers formed by reducing these declarations are:

D	5 Ahau 18 Uo,	1,399,100
E	5 Ahau 8 Cumhu,	1,400,140
F	4 Ahau 18 Uo,	1,403,480
C	4 Ahau 18 Muan,	1,403,740
G	4 Ahau 8 Cumhu,	1,404,520.

Here D and E have the same day, 5 Ahau, which means that their difference is divisible by 260. Also F, C and G have differences divisible by 260 since they return to 4 Ahau. In addition D and F have a difference divisible by 365 and the same is true of E and G, which also reach the identical month positions in the calendar year of the Mayas. In the case of G we find the 74th calendar round repetition of the epoch of the Mundane era, 13· 0· 0· 0· 0, 4 Ahau 8 Cumhu, October 13, 3,373. The Maya astronomers were doubtless developing a number of cross references between the four time counts of the Maya calendar year, the true or tropical year, the Venus calendar and the Lunar calendar. It will be seen, for instance, that 5 Ahau 18 Uo is first shifted to 5 Ahau 8 Cumhu, the day remaining the same while the month changes. Then the day changes from 5 Ahau to 4 Ahau while the month position remains fixed.

Date D can be compared as regards lunar correspondence with two most important dates at Copan, namely those reached on Altar U which relate to the second setting of the astronomical base line.

Stela C	9·14· 6· 7· 0,	5 Ahau 18 Uo,	May 23, 458 A. D., Moon 23.3 days old
Altar U	9·15· 9·10·17,	3 Caban 0 Pop,	Apr. 9, 481 A. D., Moon 23 days old
" U	9·16·12· 5·17,	6 Caban 10 Mol,	Sept. 2, 503 A. D., Moon 23.1 days old

Date E. That this is no accidental similarity as regards the handling of intervals of entire lunations must appear when we turn attention to Date E on Stela C. This has the Metonic cycle

interval from the round number 9-13-10- 0- 0, which coincided with the true new moon. Thus,

9-13-10- 0- 0,	7 Ahau	3 Cumhu,	Mar. 28, 442 A. D., Moon 0.3 of a day old
19- 5- 0			
9-14- 9- 5- 0,	5 Ahau	8 Cumhu,	Mar. 28, 461 A. D., Moon 0.0 of a day old

In other words true new moon coincidences are brought into the calculation. These should be compared with two statements of the full moon on Altar U, one falling on September 6, the autumnal station of the first setting of the astronomical base line at Copan. Stelae 10 and 12 record new and full moon dates and these monuments are the ones which define the base line, originally set for April 5 and September 6.

Date F. This last date in the list of Stela C reaches, as does Date D, the Maya month position 18 Uo which appears in the Venus table of the Dresden Codex, possibly as a date of lunar significance. It is just two Metonic cycles distant from the end of Katun 13, thus:

9-13- 0- 0- 0,	4 Ahau	8 Uo,	May 19, 432 A. D., Moon 2.3 days old
1-18-10- 0			
9-14-18-10- 0,	4 Ahau	18 Uo,	May 20, 470 A. D., Moon 2.4 days old

The summary may now be given:

A. Heliacal rising of Venus in conjunction with Moon 26.4 days old counting from midnight, or zero hour of February 4, 452.
B. A date in the distant past involving two calendarial positions of Venus and a correlation between the Metonic cycle and the Venus cycle of 243 years.
C. A date one Metonic cycle distant from the first date.
D. A date reaching the same phase of the Moon (20.3 days after new moon) as do the two most important dates on Altar U.
E. A date one Metonic cycle after 9-13-10- 0- 0 and like that reaching the new moon exactly.
F. A date two Metonic cycles after 9-13- 0- 0- 0, and declaring a lunar position 2.4 days after the new moon.

Three Achievements of Quetzalcoatl

I will close this analysis of significant Maya dates by discussing three problems in astronomy and chronology which seem to have been solved by the Toltec conqueror named Quetzalcoatl who is given credit for inventing the Mexican calendar and system of writing and for having compiled a sacred book containing historical and astronomical and ceremonial lore. He is also said to have inaugurated the ceremony of the Sacred Fire held every 52 years. The third

activity was in connection with a cult of the planet Venus which he favored and it is said that when he died on a day 1 Acatl his soul rose in the east as the morning star. We have reason to believe that these activities of Quetzalcoatl merely reflect his skill in making

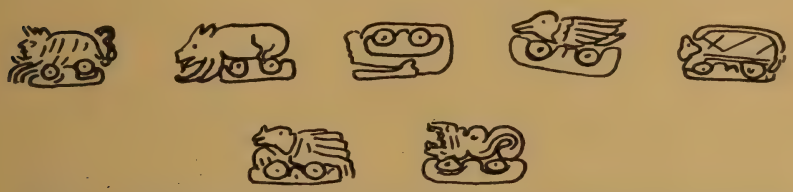

FIG. 9. VENUS IN CONJUNCTION WITH CONSTELLATIONS OF THE MAYA ZODIAC.

On Eastern Facade of the Nunnery at Chichen Itza. This facade deals with the apotheosis of Quetzalcoatl.

Maya science and religion available to the Mexican peoples who spoke a very different language from Maya.

I. FOUNDING THE TOLTEC ERA

The majority of the years counts in Mexican documents of high credibility go back to a year 1 Tecpatl, 1168 A. D. when the Toltecs were still ruling in the highlands of Mexico.[1] Other counts start from a year 2 Acatl, 1195 A. D., which is associated with the tying up of years and the new fire ceremony. Quetzalcoatl was in Yucatan in the second half of the Twelfth century, conquering Chichen Itza in 1191 A. D. A diagram of the Mexican year-bearer cycle of 52 years with each successive year counted counter-clockwise on a wheel and with Tecpatl in the north, Acatl in the east, etc., is explained by Sahagun who says:[2] "The circle inscribed above is the manner of counting the years. It is a very ancient thing. The invention of it is attributed to Quetzalcoatl."

In the *Reduction of Mayan Dates* I was able to show that the Maya and Mexican calendars exactly correspond except for two shifts, which are relatively unimportant. First, that the 5 intercalary days were inserted several months earlier in the Mexican calendar than in the Maya. Secondly, that there is a fault of one day in the synchronization of days whose names have the same meaning. Thus 1 Tecpatl of the Mexican calendar actually falls the day before 1 Eznab of the Maya calendar with which properly it should correspond.

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[1] There is some slight use of a year count which begins with 1 Tecpatl, 1220, one 52 year cycle later, at the time when the Toltec empire was breaking up and most of the large cities were being abandoned. This is the era of Toltec Dispersal.

[2] Bernardino de Sahagun, *Histoire générale des Choses de la Nouvelle-Espagne* Trans. Jourdanet and Siméon, Paris, 1880, p. 493; and portfolio of illustrations copied under direction of F. de Paso y Troncoso, Florence, 1922, *Codex Florentino*, P. C. XLV.

Thus 1 Tecpatl 1 Toxcatl of the Mexican calendar is equal in construction to 1 Eznab 6 Muan of the Maya calendar but it corresponds in time to the preceding day 13 Caban 5 Muan. For the occurrence in 1168 we have, in terms of the Maya Long Count, 11·10· 6·16·17, 13 Caban 5 Muan, August 6, 1168 A. D. This is an exact recapitulation of the epoch of the Historical era of the Mayas, which was 7· 0· 0· 0· 0, 10 Ahau 18 Zac, August 6, 613 B. C. In other words, Quetzalcoatl began his own historical era exactly 1781 true years after the Mayas began theirs. This remarkable coincidence is not accidental but is in keeping with the disclosures made in the inscriptions at Chichen Itza and Uxmal belonging to the time of Quetzalcoatl.

II. The Ceremony of the Sacred Fire

The second chronological base date that appears in the manuscripts of Mexico is the one from which the ceremony of tying up the years and lighting the sacred fire is calculated. The year, in this case, is 2 Acatl, beginning in 1195 A. D. As a point of departure in history this chronological base is generally identified with the fabled Seven Caves. The year count of the Codex Vaticanus A begins here and so also did that of the Telleriano-Remensis following the same model, although the initial page is now wanting.

The count from 2 Acatl is a carrying over of the sacred fire ceremony of the Mayas with a skillful readjustment. The proof of this is found in ceremonial days in Mexico and Yucatan connected with Quetzalcoatl on the one hand and with the sacred fire on the other, which are exactly correlated.

Sections 2 and 3 of the Mexican tonalamatl in the Telleriano-Remensis Codex relate to Quetzalcoatl. The day 7 Acatl is declared in the gloss of the latter section to be especially lucky. Under the picture is this important statement:

> "Topiltzin Quetzalcoatl was born on the day 7 Acatl and on the days of 7 Acatl at intervals of 52 years a great feast was held in Cholula to which people came from all the land and from all nations bringing great gifts to the lords and priests of the temple and the same occurs on the day when he died or went away which was 1 Acatl."

We need not be concerned greatly whether Quetzalcoatl could have invented a calendar and then signalized in it the date of his own birth, remembering that great characters in religion are given natal days on ceremonial grounds. We are reminded, for instance, that the birth of Christ was referred by the early Christians to December 25, the position of the winter solstice during the first years of the Julian calendar and the date of the Mithra feast of *Sol invictus*. The thing that is important in this case is that the interval of celebration was 52 years, or an exact calendar round.

Proceeding on the possibility that this day 7 Acatl[1] was in the year 2 Acatl, and that the new fire and the tying up of the years took place then instead of on the very day 2 Acatl with which the year commenced, we find such a day 7 Acatl as the first day of the month Panquetzaliztli. Making the same one day offset explained above we find the relation between the Toltec era of 1168 and this day 7 Acatl in terms of the Maya Long Count, to be

1 Tecpatl	1 Toxcatl	= 11-10- 6-16-17,	13 Caban	5 Muan, Aug. 6, 1168 A. D.
		1- 7- 6-15		
2 Acatl	1 Toxcatl	= 11-11-14- 5-12,	1 Eb	5 Muan, July 31, 1195 A. D.
		10- 0		
7 Acatl	1 Panquetzaliztli	= 11-11-14-15-12,	6 Eb	0 Yaxkin, Feb. 16, 1196 A. D.

In other words we reach the Maya month position 0 Yaxkin or the original beginning of the farmer's year. Let us now turn to Landa's account of a ceremony in Yucatan.

"In the tenth chapter has been related the arrival of Kukulcan,[2] after which there were some Indians who said that he had gone to heaven with the gods, and on this account they regarded him as a god and fixed a temple for him in which they should celebrate a festival to him as a god, and this was celebrated throughout all the land until the destruction of Mayapan. After this city was destroyed, it was celebrated only in the province of Mani, and the other provinces in gratitude for what they owed to Kukulcan, presented to him, one one year and another another, at Mani, sometimes four and sometimes five magnificent banners of feathers with which they solemnized the feasts in the following manner, and not like the other ones.

"On the 16th of the month Xul all the priests and lords of Mani assembled, and with them a large multitude from the towns, who came already prepared by fasts and abstinences. On the evening of that day they went forth with a great procession of people, and went with a large number of the comedians from the house of the lord where they were assembled. They proceeded very quietly to the temple of Kukulcan, which they had already adorned in proper fashion, and having arrived there and made their prayers, they placed the banners on the top of the temple. Then they all spread out their idols in the courtyard, each for himself on tree leaves which he had for this purpose. And having obtained new fire they began to burn their incense in many places and to make offerings of cooked food without salt or pepper, and of drinks made of beans and the seeds of gourds. The lords and those who had fasted remained there without returning to their houses for five days and five nights in prayer, always burning copal and engaged in their offerings, and executing several sacred dances. Until the first day of Yaxkin the comedians went for their findings among the principal houses, playing their pieces, receiving the gifts which were offered to them. They carried all of these to the temple and when the five days were ended and past, they divided the gifts among the lords, priests and dancers, and got together the banners and idols again and carried them to the house of the prince. And then each one went to his own home. They said, and considered it certain, that Kukulcan came down from heaven on the last

[1] There are several sculptures which picture the day 7 Acatl in relation to Quetzalcoatl.

[2] This is etymologically equivalent in the Maya language to the name Quetzalcoatl

day of these five days and received their services, their fasts and offerings. They called this festival Chicckaban."

There are four things to be observed about the correspondence of these two ceremonies in honor of Quetzalcoatl celebrated hundreds of miles apart, one on the highlands of Mexico and the other in the lowlands of northern Yucatan:

(a) The two ceremonies reduce, in the equivalent calendars of the Mayas and Aztecs, to the same day in the initial position of the same month.

(b) The duration of the ceremony at the time of its inauguration practically closed the gap between February 10 and February 16 and therefore may have been intended to bring the Maya epoch of the era of the Chronicles into the scope of significance. The new fire ceremony was surely celebrated in connection with this era, as also at other times.

(c) The Maya ceremony in which feather banners were used is in agreement with the Mexican name Panquetzaliztli, month of the Feather Banners. At the time of the Conquest this month was sacred to Huitzilopochtli, the Aztec God of War, but it may have been stolen from Quetzalcoatl as the original patron.

(d) The Maya ceremony was celebrated annually and the Mexican ceremony at intervals of 52 years, perhaps with a lesser observance on each recurrence of the day 7 Acatl, but the name Panquetzaliztli suggests that the ceremony may once have been annual in the Valley of Mexico.

III. Quetzalcoatl and the Venus Calendar

Quetzalcoatl is said to have died on a day 1 Acatl and in his guise as God of the Planet Venus he is pictured in conjunction with the sign 1 Acatl. Also there was a belief that this 1 Acatl was in the year 1 Acatl, hence his fabled return was confused with the coming of Cortes, for 1519 was such a year. But the year 1 Acatl of Quetzalcoatl's death was none other than the Mexican year corresponding in part to 1208 A. D.

What happened in the year 1 Acatl, or on the day 1 Acatl that can be involved in the myth of Quetzalcoatl and the planet Venus? Calendar B of the Dresden Codex was then designating with sharp accuracy the days of the heliacal risings of Venus in the ancient positions of the Venus calendar and such an heliacal rising took place on the Maya date 11·12· 7· 3·12, 13 Eb 0 Yax, April 13, 1208 A. D. Remembering the one day discrepancy between the Maya tzolkin and the Mexican tonalamatl the day 13 Eb becomes chronologically equivalent, not with its cognate 13 Malinalli, but with the following day 1 Acatl. All the conditions of the Quet-

zalcoatl legend are justified for the Toltec overlord died—perhaps he was slain—on the 1 Acatl 1 Itzcalli, the first day of the fourteenth month in the year 1 Acatl. There is a well known statement in the Annals of Cuauhtitlan concerning the fatalities that the first vision of Venus at heliacal rising as morning star brings about: "on the day Acatl it shoots the kings".

The order in which the Aztec cycle called Ueuetiliztli, and meaning the age, was counted after this beginning was identical with the 104 year permutation of the Maya. Whether the Mexicans used the supplementary shift of 12 days forward in the month at the end of 251 years is doubtful. The five days of beginning are generally arranged Cipactli, Acatl, Coatl, Olin and Atl, the formal permutation beginning from or with 1 Cipactli. This would be equivalent to using the Maya position 13 Ahau as the point of departure. Perhaps 1 Cipactli was chosen because of its schematic importance as the first day of the Mexican tonalamatl rather than because of its chronological equality to Ahau. But counting back 7592 days, or 13 Venus revolutions, from the disclosed beginning of Quetzalcoatl's calendar brings us to the following position in the Maya system:

11·12· 7· 3·12,	13 Eb	0 Yax,	Apr. 13, 1208 A. D.
1· 1· 1·12	subtract		
11·11· 6· 2· 0,	13 Ahau	13 Mac,	July 1, 1187 A. D.

In other words if the Mexican count of Venus is made to depart from a day Cipactli it falls into accord with Calendar B of the Dresden Codex.

Conclusions

The conclusions drawn from this study are

1. That the Maya calendars of Venus and the Moon were uncorrected patterns of intervals.

2. That the ceremonial days were those of the original settings, *a* in the Maya year, *b* in the tropical year.

3. That actual phases of Venus and the Moon were sometimes recorded on dates of multiple significance: *a* on round numbers in the day count, *b* on natural points of the tropical year (equinoxes, solstices, astronomical base line dates, true anniversaries of the epochs of the eras, etc.).

4. That the principal purposes must have been religious or astrological but that astronomical accuracy was demanded.

5. That the correlation explained in the *Reduction of Mayan Dates* is accurate and sufficient to solve the astronomical data of the ancient inscriptions.

6. That Mexican chronology rests on the earlier achievements of the Maya.

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